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THE MAGAZINE OF APPLIED ENGINEERING
TECHNOLOGY

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**SPACE A-24 Plastics Show of Canada, Toronto, October 17-19**

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**PLASTICS**
THE MAGAZINE OF APPLIED ENGINEERING
**TECHNOLOGY**
September 1961, Vol. 7, No. 9

*feature articles*

**PROTOTYPE AND MOLD FABRICATION** . . . . . p.23
*by D. E. Diez and H. G. Schaeffer*
Materials used in mold construction vary with the processing technique employed, length of run, and complexity of the desired part. Problems encountered include heat dissipation, which involves both temperature control and thermal conductivity.

**THERMOFORMING PROCESSES AND APPLICATIONS** . . . . . p.29
*by John R. Lynch*
A tie-in with last month's article by Mr. Lynch, it covers machine components and types used, mold construction, and design considerations.

**WHAT'S THE FUTURE OF YOUR COMPANY?** . . . . . p.35
*by Dale Amos*
Custom molding futures are very uncertain, according to Mr. Amos, since molders are selling machine time—not engineering ability. A new look should be taken into future markets, and into new applications for plastics.

**EQUIPMENT FOR DETERMINING LOW-TEMPERATURE CREEP** . . . p.39
*by E. Van Antwerp*
Glass-reinforced laminates are stable at ambient and elevated temperatures, but what about low-temperature stress-rupture? Equipment for measuring this from room temperature to —30° F. is described.

**MECHANICAL-ACOUSTICAL BEHAVIOR OF POLYSTRENE FOAM** . . p.39
*by Dr. Helmuth Osken*
Dynamically, polystyrene foam is rather hard. From an acoustical standpoint, its resilient properties have been utilized to deaden sound while simultaneously providing high thermal insulation.

**ALL-PLASTIC INSULATION IMPROVES REEFER PERFORMANCE** . . p.41
Polystyrene foam is combined with ABS sheeting to form a plastic sandwich insulating panel for refrigerator car doors.

*exploring fabrication techniques*

**CONTINUOUS DEGASSING OF LIQUID RESINS** . . . . . p.42
This continuous method replaces the batch method, which was both wasteful and ponderous. It allows a complete manufacturing line instead of interrupted operations.

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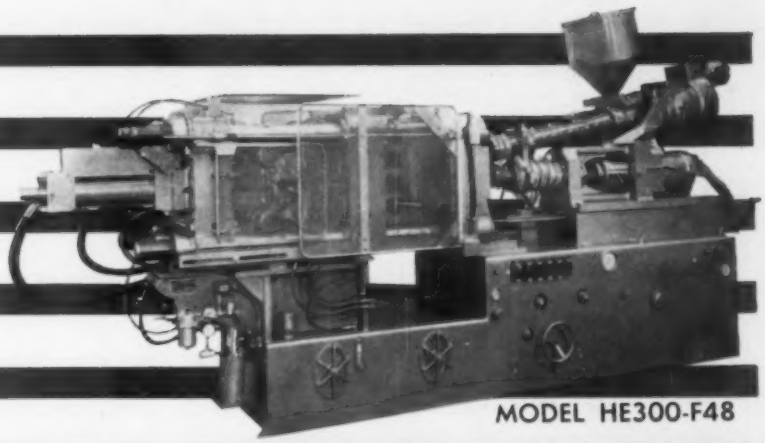

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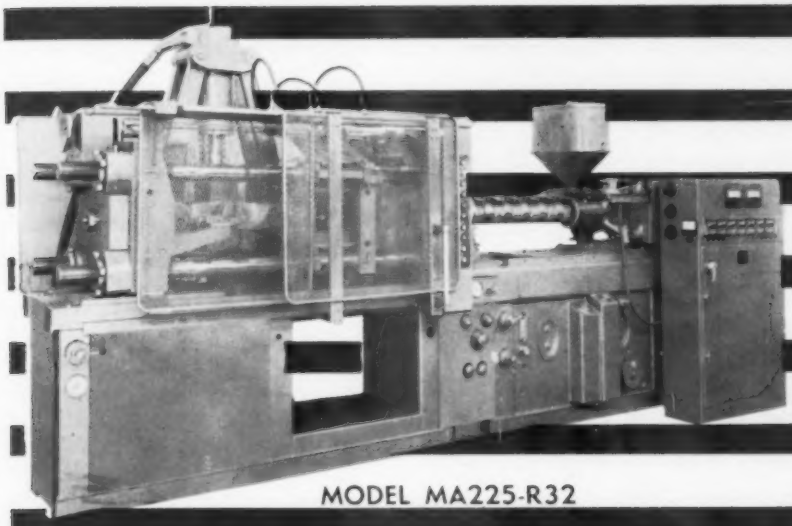

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# Letters to the editors

Sirs:

Reading Lou Barnett's letter regarding the National Plastics Exposition here in New York can only give us the feeling of having heard this before. [In the July issue, Mr. Barnett protested that curiosity seekers prevented those who were really interested from accomplishing any business.]

As exhibitors, we were extremely unhappy to find ourselves across the aisle from a "gimmick dispenser." The queue blocked off part of our exhibit, made passage of the aisle difficult, and made us wonder a little about the psychology of what Mr. Barnett calls curiosity seekers. Since many of these people were sitting in our lap for a good part of the Show, we asked a few, as nicely as possible, why they were standing in line for up to one-half hour to get hold of a plastic colander that they could buy in Woolworth's for a quarter. The answer invariably was, "It's not for me; it's for the kids"; and then they would usually go on to complain about the length of the line and the time they were spending in it. Our suggestion was that they buy a dollar's worth of plastic items which would be more appropriate for children and tell them it was from the Plastics Show. This was met with hostility and scorn. Perhaps this is a proper reaction.

Anyway, we were sick and tired of giveaway items produced by machine manufacturers, and we got sick and tired of the people, who seem to demand these items, cluttering up the Show.

*Foster Nostrand,*
*Sales Prom. Mgr.*
*Dapon Department*
*FMC Corp.*

• • •

Sirs:

In PLASTICS TECHNOLOGY, July 1961, your article on "Polypropylene Monofilament Extrusion," Fig. 8, the wind-up motors are described as constant torque motors. This is a somewhat misleading statement.

Torque motors are special designs of polyphase induction motors. They are not constant torque motors, but rather constant horsepower motors. Winding operation of an extruder requires constant take-up speed and constant tension of the material being extruded. Therefore the winding motor must have a speed-torque characteristic which provides the correct *changing* torque as determined by the changing diameter of the winding reel. The torque motor automatically winds the material at a speed determined by the tension and the reel diameter without the use of mechanical tension devices. The desired tension is controlled by the voltage input for the torque motor.

*A. J. Hambach, Proj. Eng.*
*Smitherm Division*
*Hupp Corp.*

• • •

We invite letters from our readers for publication in these columns. Such letters may be of comment or criticism, requests for information, or of general interest. The only requirement is that all letters must be fully identified as to name of sender, company affiliation and address.

A letter will not be printed if publication is not desired by the sender, and the identity of the writer will be withheld, if desired.

—The Editor

## Articles on schedule

Pour-in-place Urethanes for Insulation—an article from Nopco Chemical Co. This long and very comprehensive article will probably be carried as a two-part work in the next two succeeding months. Based primarily on the firm's new H-602 formulation, the article covers physical properties, chemical components, control density and foaming characteristics, prototype pouring, density distribution in panels, mold preparation, cycle time, metering and mixing, and test procedures. Considerable graphic data are included.

•

An article on Polyvinyl Chloride Footwear by Gilbert Darcy of Holeproof Hosiery. A particularly important feature is the bonding of vinyl soles to leather upper stock. Nylon inserts and silicone slip are also covered.

•

T. Kaplan and I. Gordon of Kapgo Plastics have come up with an article on molds for blow molding. Of special interest are some of the refinements which can be built-in the mold, including toggles for release, etc. Some finishing operations in blow molding are covered.

•

The special section in November which will cover specifications for 1961 extrusion machines and auxiliary equipment. Machines have to be American made—or available locally. This is an up-dating of the specifications which appeared in the September, 1960, issue. As usual, the data will be accompanied by an article on extrusion—recent developments and some specifics.

•

Other subjects we plan to cover in the near future include pigments, dyes, and colorants for plastics; piping, and instrumentation for testing at the processor level.

•


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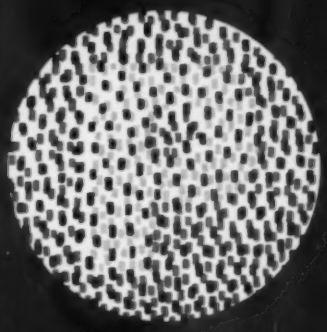

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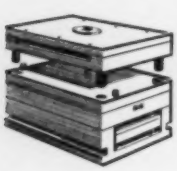

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CHEMICAL MATERIALS CATALOG, Page 179

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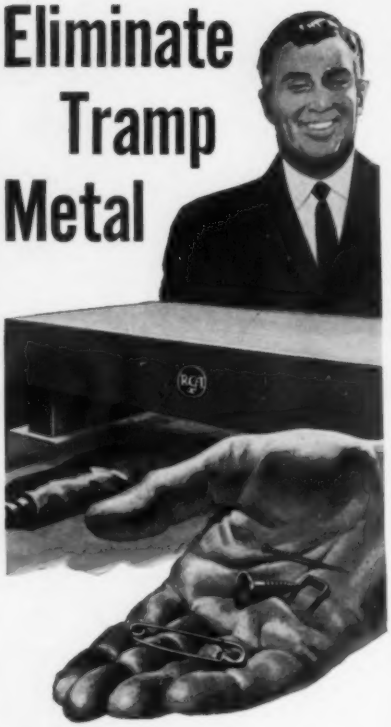

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# What's New in Processing

**A process for casting massive nylon shapes** directly from raw materials has been introduced by Polymer Corp., Reading, Pa. By the process, MC nylon (a type 6 formulation) is cast from caprolactam monomer without pressure. Reported to be similar in techniques and costs to the conventional casting of metals, the monomer casting is based on chemistry developed by Monsanto. Among the advantages of the process are low exothermic reaction and lack of porosity in the finished casting.

**Bostrom Corp. is molding urethane foam within a preformed skin** of synthetic rubber to provide an integrally bonded seat and cushion. The Milwaukee concern pours a mixture of organic isocyanate (DuPont's Hylene), polyol, water, and a catalyst into a vacuum formed skin of DuPont's Hypalon. Since the skin, vacuum formed by Ohio Rubber Co., has no memory, it is not subject to the structural weaknesses of conventionally woven materials. The union of foam and rubber increases the tensile strength and tear resistance of both materials. The process is used to manufacture foam cushioned tractor seat capable of withstanding severe wear and weather conditions.

## Abstracts

**"Coating by the Zimmer Process"** by P. J. Visser, Plastics, March 1961, describes technical details of a machine which produces film up to 60 inches wide. The film is used for coating aluminum, paper, fabric, or other substrates.

**"Spray Method for Glass/Polyester Parts"** by J. Coudenhove-Kalergi, Plastverarbeiter, March 1961, reviews the advantages of the spray method, and discusses some new equipment for it.

**"Production of Film and Sheet"** by R. Angusta, Revista Plasticos, March-April 1961, supplies detail on the methods and equipment for extruding and blowing film and sheet

**"Processing Semifinished Polyolefin Goods"** by H. Domininghaus, Kunststoff-Rundschau, March 1961, covers the welding, adhesive joining, and machining of polyolefin parts.

**"Development and Application of the Resin/Fiber Spray Process"** by H. Hanusch, Kunststoff-Rundschau, March 1961, describes one American and one German process and equipment for simultaneous spraying of chopped fiber and resin compounds.

## Patents

**2,978,751** to Du Bois Plastic Products, Inc. A method of making composite, molded, thermoplastic wheels.

**2,977,839** to Polymer Corp. A method of applying a braided textile covering to the surface of nylon tubing.

**2,977,637** to Conso Realty Co. A method for molding articles consisting of a reinforcing mat between thin films of plastic material.

**2,977,639** to Monsanto Chemical Co. A process for preparing an article consisting of a styrene polymer foam having a formed thermoplastic sheet laminated to at least one of its surfaces.

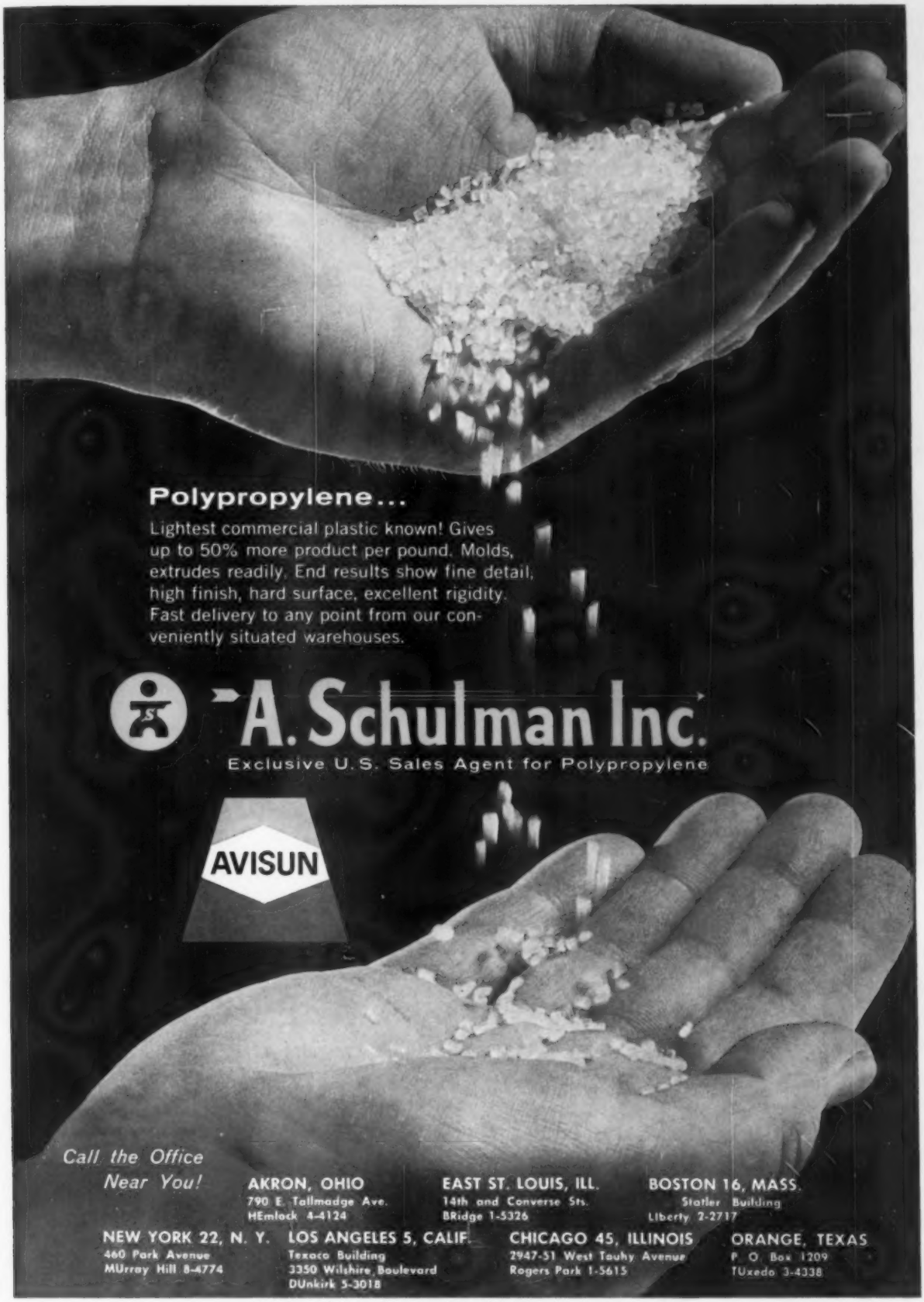
**2,981,979** to Phillips Petroleum Co. Porous articles are fabricated from powdered polyethylene mixed with talc and metal stearate by sintering.

**2,979,419** to Dow Chemical. Process for upgrading articles prepared from monoalkenyl aromatic polymers by coating with clear-drying latices.

**2,980,963** to American Can Co. Method of producing plastic containers includes the steps of extruding thermoplastic tubes, printing them on rotary mandrels, and injection molding a head.

**2,980,964** to Distillers Co., Ltd., Edinburgh, Scotland. Method of forming linear polyethylene films of improved transparency.

**2,980,965** to American Machine & Foundry Co. Polytetrafluoroethylene in dispersion is cast on an aluminum surface, then dried and sintered to form a film.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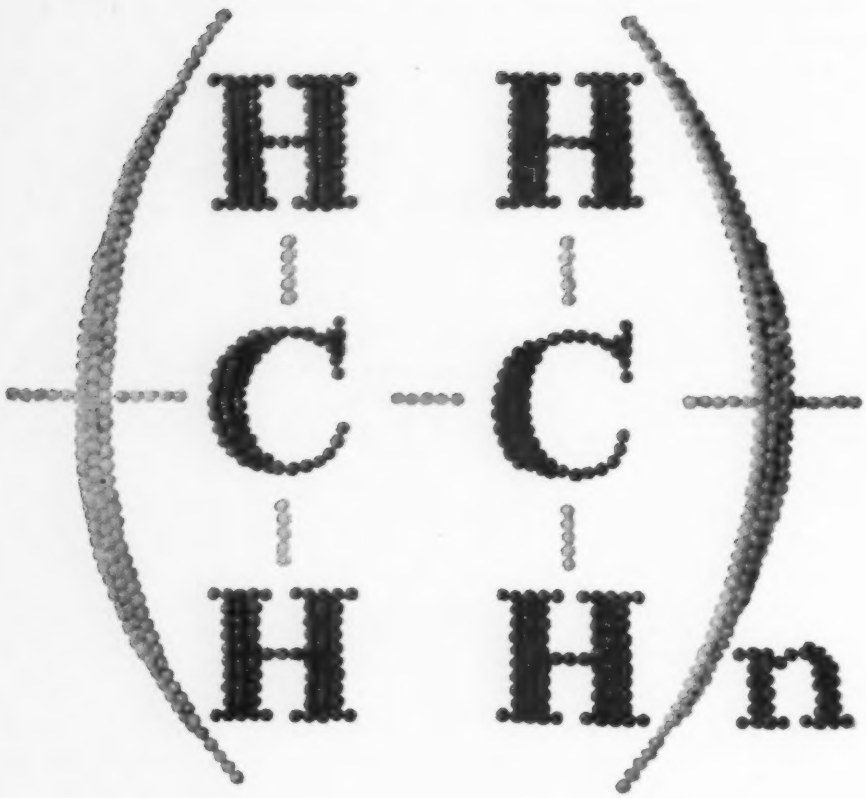
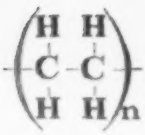



# THAT EXTRA TOUCH OF GRACE: Technical Information

**The flood of daily data about new plastics resins, equipment and developments in molding and fabricating seems never-ending. How can any one person keep up with it? The Grace staff is prepared to help plastic resin customers in their search for specific technical information. Your Grace representative offers a variety of Grace publications plus the literature resources of the Grace libraries. This is another of the ten major services available under the Grace Service Plan; your representative has details.**

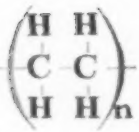


## TECHNICAL INFORMATION ON BLOW MOLDING

**The following bulletins and reprints are available: Blow Molding of Hollow Objects With High Density Polyethylene; Engineering Aspects of Blow Molding Linear Polyethylene; Blow Molded Containers: Collapse Problems-Recommended Solutions; Low Density Polyethylene Resins For Blow Molding; Blow Molding (Reprint-British Plastics); Blow Molded High Density Polyethylene Containers For Household Bleach; Packaging of Gasoline in High Density Polyethylene Containers; Selection of High Density Polyethylene Resins For Liquid Starch and Textile Rinse Containers. Ask for your Copy.**

## TECHNICAL INFORMATION ON INJECTION MOLDING

**The following bulletins and reprints are available: Molder's Guide to Injection Molding of High Density Polyethylene; Improved Dry Coloring With High Density Polyethylene; Mold Finishes For High Density Polyethylene; Dry Tumbled Blends With High Density Polyethylene; Low and Medium Density Polyethylene Resins For Injection Molding; High Density Polyethylene Blends For Injection Molding. Ask for your Copy.**



## TECHNICAL INFORMATION ON EXTRUSION

**The following bulletins and reprints are available: Fabricator's Guide to Extruding High Density Polyethylene; Plastic Pipe From High Density Polyethylene; Film Grade Resin 2201; Low Density Polyethylene Resins For Flat and Blown Film Extrusion; Design Stresses For Polyethylene Pipe; The Monofilament Tester; Techniques in the Extrusion of High Density Polyethylene Tubing and Profiles. Ask for your Copy.**

**Your Grace representative can supply you with this literature, and other technical information on plastics . . . product and techniques. Call on him for what you want. And don't forget to ask him how the Grace Service Plan can help augment your own organization in these other important service areas: market research, product design, mold design, market development, technical service, financial counseling, delivery and merchandising. Find out how to put that extra touch of Grace to work for you.**

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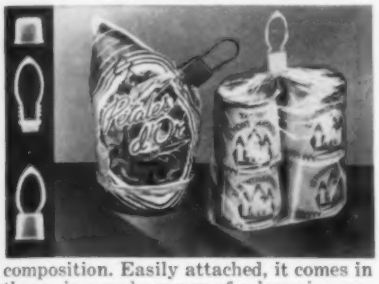
# U.S.I. POLYETHYLENE NEWS

A series of advertisements for plastics and packaging executives by the makers of PETROTHENE® polyethylene resins

SEPTEMBER, 1961 — U. S. Industrial Chemicals Co., Division of National Distillers and Chemical Corporation — 99 Park Ave., N. Y. 16, N. Y.


## Packaging Notes

**Reusable closure** for polyethylene bags is airtight — protects against humidity, leakage, odors, mildew, hardening, de-

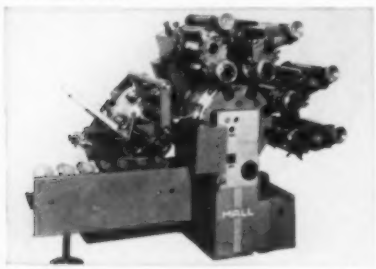


composition. Easily attached, it comes in three sizes and a range of colors; is especially suitable for rack display and tie-in merchandising. This clip, originated in France, has been widely used in Europe for packaging foods, chemicals, drugs, precision instruments, notions, sweaters. A Yonkers, N. Y., company is the American manufacturer and distributor.

**Adjustable-flow bottle** for hydrofluoric acid is molded entirely of polyethylene. Unique closure (design patented) permits user to actually "dial" the rate of flow—from a single drop to a steady stream. There's no diaphragm to puncture: the one-pound container has a slip-on dust cover which protects against contamination and leakage.

**New primer,** said to be an excellent adhesion promoter, does away with the need to age film surfaces prior to extrusion coating with polyethylene. Can be used on cellophane, polyester, aluminum, many other films and foils. Application is by wash coat. Coverage: 10 lbs. per 3,000 sq. ft. wet.

**Offset printing machine** decorates round and tapered polyethylene containers and bottles in four colors at a production speed of 80 pieces per minute, maximum. It handles bottles up to 13 inches high, four-inch diameter full circumference and six-inch diameter ⅔ of circumference.



# First Commercial Products Of U. S. I.'s Powdered Polyethylene Introduced

### Outsize Items Molded from MICROTHENE® by New Technology

One ton-capacity meat tanks, nine-foot long boats and 13-gallon containers are among the first products made of powdered polyethylene to be marketed in the U.S. All three are being produced by powder molding. This is a new polyethylene technology used in Europe, but relatively unknown in America until U.S.I.'s MICROTHENE became available nearly two years ago.

Tough, lightweight boat hull is made from U.S.I.'s MICROTHENE finely-divided polyethylene. It will retail at a price lower than comparable boats of reinforced plastics.

#### Process is fast, easy, economical

Larger than ordinary moldings can be made from powdered polyethylene. The process is fast and requires simple, relatively inexpensive molds. Ease and economy of production give many items made by this method a price advantage over those molded by conventional procedures.

The new boat, molded from black MICROTHENE by an Indiana company, is typical. It has the first full-sized hull made of conventional polyethylene, without the use of wood or metal inserts for stiffening. It will retail at a price lower than comparable boats. It won't rust or dent. Can be used with outboard motors up to 5 hp.

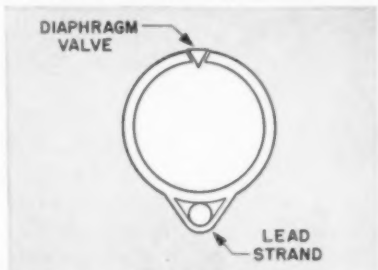
The same company utilizes MICROTHENE to produce a meat tank for use in packing and processing plants. It is thick-walled, easily cleaned and resistant to juices and chemicals; holds one ton of liquid or bulk product.

The 13-gallon MICROTHENE "bottle", produced in Brooklyn, N. Y., is lighter and takes less storage space than the glass carboys it's designed to replace. It is also unbreakable and corrosion resistant — characteristics which virtually assure its success in the chemical industry. The manufacturer has received ICC certification for the 13-gallon container. The company can reportedly produce up to 800 of the units in a normal 40-hour production week.

Extra-large meat tank made of MICROTHENE—designed for transporting, storing or process-handling meats—is one of the first results of the new polyethylene technology called powder molding.

## Ice Melting System Uses Polyethylene Tubing

Weighted polyethylene tubing is an integral part of an automatic aerating and ice melting system currently being marketed. The equipment, inexpensive to install and operate, is designed to provide year-round open water for wildlife sanctuaries . . . prevent winter fish-kill . . . and eliminate ice damage to docks, piers, boats, locks, dams, etc.




As shown in the schematic drawing, the tubing has a built-in strand of lead along the bottom and diaphragm valves at given intervals along the top.

During service, needle-point amounts of oil-free air are forced into the water through the valves in the submerged hose. The air gently circulates the earth-warmed bottom water — which aids in ice melting. The air also furnishes oxygen for the fish, and for burning up organic debris.

For more information check Readers' Service Card No. 111

U.S.I.

Series VI, No. 5

# POLYETHYLENE PROCESSING TIPS

## HONING AND REPLATING EXTRUDER DIE LANDS

Cleaning and polishing the die lands of polyethylene film extruders and extrusion coaters on a regular basis will minimize the amount of poor quality production resulting from contaminated die lands. Procedures for such maintenance were outlined in a previous *U.S.I. Polyethylene Processing Tips*—Series VI, No. 4.

Even with the best care, however, it still is necessary to refinish the die lands periodically either by honing or, if they are chrome plated, by replating. Lands need refinishing if they have rough spots (as shown by lines in the polyethylene film or coating) that cannot be eliminated by cleaning and polishing.

### Honing Flat Film Die Lands

The procedure for honing flat film and extrusion coater die lands is as follows:

1. Fabricate a holder of soft material that will not mark the lands for the honing stone, similar to the one shown in Figure 1. Wood or Micarta plastic are two suitable materials for the holder.

2. Be sure the lands are cool before honing. Hot lands are easily marked.

3. Place the lands, or jaws if they are in one piece, in a table vise so that the lands are upright. See Figure 2.

4. Hone the lands, keeping the stones wet with kerosene during the entire honing operation.

- Start with a 400 grit stone in the holder. Hone the lands until all visible imperfections are removed.
- Follow with a 600 grit stone. Continue honing until a very smooth surface is obtained.
- If desirable, hone briefly with an 800 grit stone for a mirror finish.

### Precautions During Honing

While the die lands are being honed, it is extremely important to hold them in an upright position in a rigid mounting block or vise, as shown. The stone must be positioned firmly in the holder so that the stone will be flat against the lands' surface at all times. Never try to hone only a small area of the lands—hone across their entire length with smooth, even strokes. As you hone, be sure to keep the stone free from small bits of metal. These will undo your work by scratching the die lands.

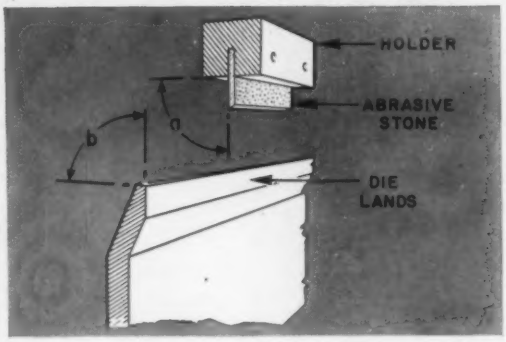



Figure 1—Honing stone and holder for honing flat film or extrusion coater die lands. Notice that angle between holder and stone (a) corresponds to angle between die land and face of die lip (b), 90° in this case.

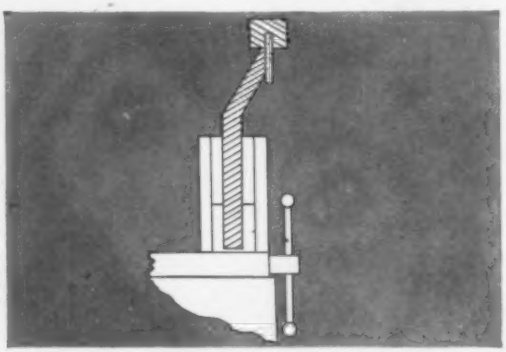


Figure 2—End view of die land honing operation.

Honing a set of die lands takes several hours. Therefore, it's a good idea to have a spare set available so that the extruder can operate while one set of die lands is being honed.

Only a precision machine shop should hone blown film dies. If your plant doesn't have one, send the dies out to an experienced shop for honing.

### Special Treatment for Plated Dies

Chrome plated dies must be handled with extreme care. Honing will remove the chrome plate and is *not* recommended. If you can't smooth chrome plated dies by cleaning and polishing, send them out for replating by the die manufacturer or a shop experienced in such work.

U.S.I. INDUSTRIAL CHEMICALS CO.
Division of National Distillers and Chemical Corp.
99 Park Ave., New York 16, N. Y.
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# *editorial:* CUSTOM MOLDER OR SUB-CONTRACTOR?

I was talking to a custom molder the other day who complained bitterly that he was getting only about $6 per hour for press time as opposed to $30 a couple of years ago. When a molder gets that little on a $30,000 machine, he becomes little more than a sub-contractor no matter how often he stresses his engineering skills. A rose is a rose is a rose.

Instability of material prices is far from being the sole culprit responsible for custom molders' problems. Something has to be done to upgrade the engineering aspects of plastics processing. It's long been an established fact that no one will place a higher price on your skills and services than you do yourself. And you're not selling engineering when you quote on press time alone.

A good custom molder does not merely convert raw material into finished items. He is involved in determining the most economical production techniques, creating new designs, developing applications. He has to create—new markets, new business, new applications for plastics. He doesn't sit back and wait for the material supplier to do the job for him. The supplier may be better equipped for research and development, but the promotion and development of new applications is primarily the responsibility of the molder.

The various industries must be provided with new concepts of materials and design. Remember, too, the many good applications which failed due to poor functional performance. Economics are important, of course, but engineering skill is mandatory. In this way, the molder can diversify, thus broadening his market base and reducing his dependency on restricted outlets. It's no secret, either, that the profit margin is highest on a new application.

The biggest menace to the custom molding industry is captive molding. Did it ever occur to you just why there is so much more interest in captive operations? They are very difficult to run successfully; they are expensive to set up; and management often does not understand the problems involved. The answer seems very simple. Companies establish a molding division or department because they are not satisfied with what they are getting from a custom molder. And you can't blame price, because many bids are so low that a company couldn't possibly do it cheaper themselves.

It has to be the product. You can't engineer a product for $6 press time. We said it last month and we will say it again—there are some things which you just can't give away. But quality sells, and so do new ideas systematically worked out. We've just scratched the surface. Now is the time to dig!

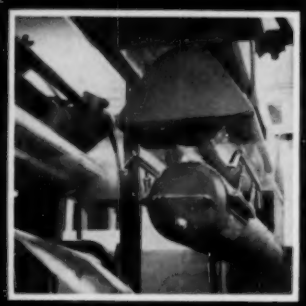
Jim Dugan

Editor

CURTISS WRIGHT

# BETAMETER®

**Assures Uniformity to 0.00025"**



Mr. Lorentz, right, and Mr. Anthony Robinson, Supervisor of Styroflex Division, discuss production results as displayed on the BetaMeter Control Console. Above inset shows BetaMeter in operation.

## *"Quality is our prime consideration at Natvar"*

*All Styroflex operations at Natvar are carefully controlled to uphold quality standards.*

". . . and Curtiss-Wright BetaMeter gives us round-the-clock quality control of our custom-formulated Styroflex film," states Mr. Robert C. Lorentz, plant manager of Natvar Corporation, Woodbridge, New Jersey.

Natvar Corporation is a leading manufacturer of flexible insulation for electronic and electrical industries throughout the world. For the precise production of Styroflex film, Natvar relies on Curtiss-Wright BetaMeters to assure and maintain exact uniformity down to 0.00025" film.

The BetaMeter is ideal for all applications where close tolerances and finest quality are of prime importance. Variations in thickness are instantly detected and recorded during actual production. Material being measured is not contacted nor is the process affected in any way. The Curtiss-Wright BetaMeter permits optimum control of production variables, improves quality and increases profits by reducing costly scrap losses.

Automatic process control equipment is available for all standard BetaMeter measuring systems.

For information on how the Curtiss-Wright BetaMeter can benefit your plastic film, sheet or coated stock operation, phone SWinburne 9-0500 or write.

**Curtiss-Wright Mark II BetaMeters, for handling up to 36" webs, are priced from $4985** (Strip-chart recorder included).

**Princeton Division CURTISS WRIGHT CORPORATION Princeton, New Jersey**

*IN CANADA: Canadian Curtiss-Wright Ltd., Industrial Process Controls, Davis Road, Oakville, Ontario*

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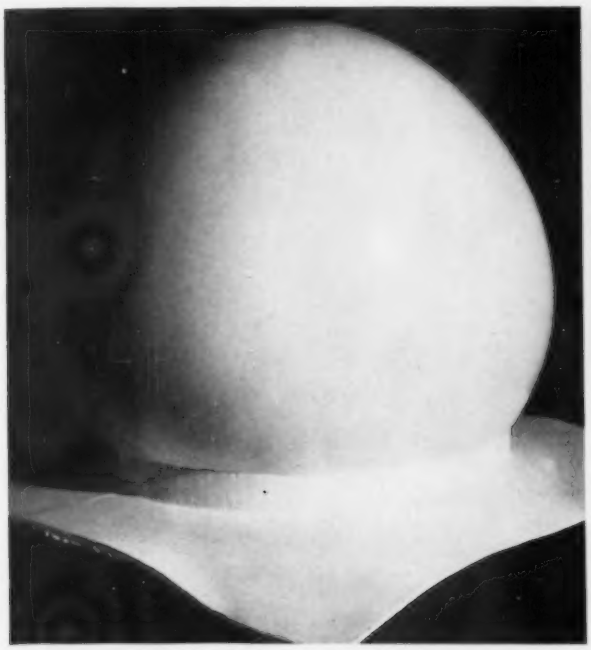

PVC sheets (12"x12"x⅛") were heated for 4 min. at 350°F., then subjected to gradually-raised air pressure. *Upper left:* Sheet containing 10% ACRYLOID® K-120N flowed easily to form smooth sphere. *Upper right:* Unmodified PVC (high pressures cause sample to tear). *Lower right:* Fixture used for applying air pressure.

## ACRYLOID K-120N for smooth flow, easy formability with PVC

Rigid vinyls flow as easily as demonstrated above, if you add ACRYLOID K-120N. As little as 5 percent of this acrylic-resin modifier provides remarkable improvement in processing and forming properties to either rigid or plasticized vinyls. Easy workability is particularly apparent in calendering, extrusion, and vacuum forming. The fine, uniform particle size of ACRYLOID K-120N makes this modifier easy to disperse in PVC resins. We will gladly send you technical literature on ACRYLOID K-120N and on Rohm & Haas' complete line of plasticizers for vinyls.

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PHILADELPHIA 5, PA.

# ACRYLOID

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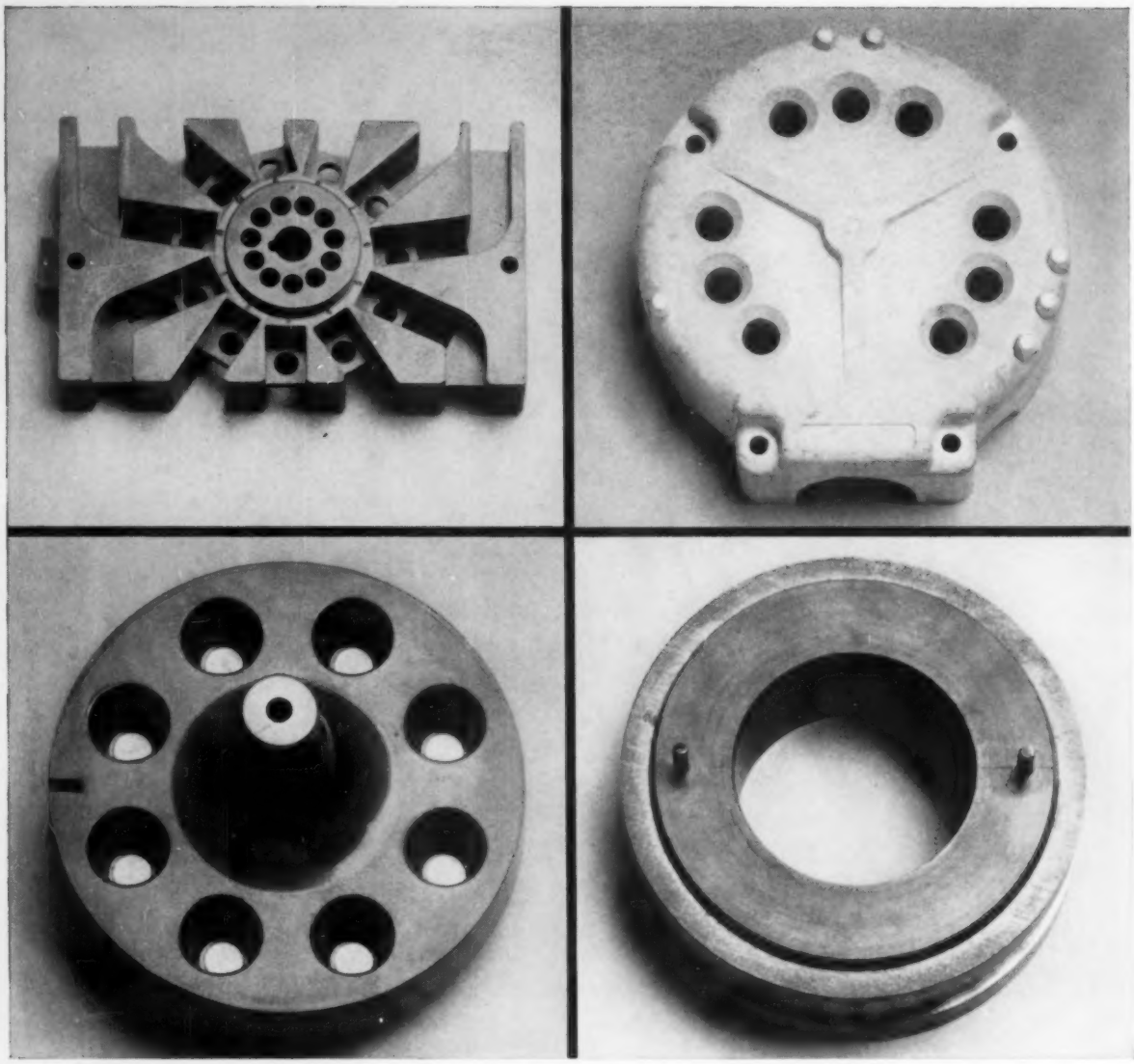

## All things considered, CYMEL® MELAMINE is the plastic to consider.

**Consider basic properties of Cymel melamine plastic:** Hardest surface of any plastic yet developed • best wear resistance • high impact resistance • outstanding electrical properties under adverse conditions • extraordinary flame resistance • good dimensional stability • resistance to heat, boiling water and attack by solvents. ■ **Consider applications:** Cymel **592** (asbestos filled) for auto and aircraft ignition parts, radio, television and other electronic equipment components, circuit breakers, terminal blocks, switch gears. Cymel **1500** (wood flour filled) and Cymel **1502** (alpha cellulose filled) for auto ignition parts, connector plugs, industrial housings, meter blocks, wiring devices, switch gear housings. Cymel **3135** and **3136** (glass fiber filled) for heavy duty naval, military and industrial switch gears, electrical and electronic components, coil forms, terminal strips, stand-off insulators. Cymel **3020** (fabric filled) for terminal strips and circuit breakers. ■ Consider the fact that other Cymel molding compounds are available for applications where beauty and color are essential. For complete information and technical assistance, contact your nearest Cyanamid office listed below.

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PLASTICS
THE MAGAZINE OF APPLIED ENGINEERING
TECHNOLOGY

# Prototype and mold fabrication

**The various materials used in mold construction are presented, along with suggestions for use depending on processing technique employed, length of run, and complexity of the finished item. Problems encountered include heat dissipation, which involves both temperature control and thermal conductivity. Actual techniques for molding are discussed.—Editor.**

H. G. SCHAEFFER** D. E. DIEZ*

The increasing interest in blow molding, thermoforming, and other techniques which require variously shaped and sized molds has prompted Union Carbide Plastics Company Development Laboratories to evaluate numerous mold materials and fabrication techniques. As a result of these studies, considerable experience has been developed in mold making techniques by laboratory or inexpensive methods. A better understanding has also been gained into the problems and limitations of commercial mold making. It is hoped that the information presented here will be of value to anyone making or contemplating the construction of prototype models or molds.

## Mold Materials

Molds can be fabricated from structural materials, constructed from an existing prototype, or can be made by using a model of the desired finished part. In the latter case, material is cast around the part to obtain the mold. The majority of molds made in our laboratories for prototype work involved an existing piece or one made as described. However, where no previous piece existed, we consulted model makers and designers or fashioned the initial piece from materials and techniques available. Many prototype molds were made of wood, metal, rubber, epoxies, and other resins to determine their suitability. Thermal conductivity and ability of mold materials to dissipate heat were primary considerations. The following is an evaluation of each of the materials available for mold construction:

### Wood

Wood is an inexpensive material for smooth surfaced shapes requiring no intricate detail carving. It can also be worked into a desired shape in fairly short order. Male molds for drape forming are often made from wood because the male shape can be sawed, chiseled, filed, and sanded to the desired form. Hardwoods such as birch, cherry, or mahogany are preferred over softwoods such as pine, fir, or balsa. Hot plastic sheets tend to adhere to wood, especially the softwoods, even after cooling. A mold coating such as epoxy or short tung oil phenolic varnish which will withstand the heat applied by the hot plastic sheet, will improve the mold. Although the number of continuous runs is limited to about 50 because of warpage and cracking, the life of wood molds can be extended to 200-300 by using intermittent cycles.

### Metal

Aluminum and copper are excellent for heat transfer properties, with thermal conductivities of 4900 and 9000 x $10^{-4}$ cal/(sec.)(cm.$^2$)(°C./cm). respectively. Stainless steel and carbon steels, which are suitable for machining into various mold shapes, have somewhat lower thermal conductivities (400 to 1100 x $10^{-4}$) than aluminum and copper, but are much better than wood (2 to 5 x $10^{-4}$), plaster (10 x $10^{-4}$), and glass (12 to 26 x $10^{-4}$). These metals can be worked into desired mold shapes for small runs and laboratory experiments, but the costs of machining or casting generally dictate their application to commer-

* Development Engineer.
** Technical Service Engineer, Sales.
Union Carbide Plastics Company, New York, N.Y.

Box molds of sintered metal for thermoforming.

Plaster pattern for epoxy mold.

cial production equipment.

### Plaster of Paris

A variety of plaster of Paris compounds are available which exhibit slight differences in strength, hardness, and cost; but all are easily worked. "Ultracal 30", made by U. S. Gypsum, Inc., gave very good results, as did their "Hydrocal A-11" and "Ultracal 60." Viscosities are determined by varying the amount of water added to the plaster, with the choice depending on the shape being reproduced or the amount of detail involved. The plaster can be poured readily around an existing prototype, provided a suitable release agent has been applied. Acceptable agents include silicone sprays such as Devcon# silicone wax and Dow Corning## stopcock grease. If casting is not possible, the thick plaster is prepared (100 parts by weight of plaster to 37 parts of water) and troweled about the prototype.

Plaster sets fairly fast (10-30 minutes in thin sections) and can be formed into a mold very quickly. An additional 5-7 days at room temperature, or 120-130°F. overnight, is necessary to cure plaster to a useful hardness—especially when excess water has been added to make a thin, flowable mixture. These low viscosity mixtures provide slightly weaker castings.

Plaster of Paris is very suitable for filling or backing up the plastic in epoxy molds, since the epoxy exotherm might otherwise distort it. Plaster molds are used for thermoforming runs of less than 50. Longer continuous exposure tends to crack the mold, with thinned sections and raised letters being especially vulnerable.

### Foam or porous non-metal

Foams and porous materials have the advantage of light weight, which is important for ease of handling in the larger molds. However, their general resistance to abuse from handling is not very high, and their compressive strengths are often inadequate. Phenolic foams of higher density (>5 lb/ft.$^3$) exhibit greater resistance to collapse in pressure or vacuum forming, but are more difficult to shape. The surfaces are generally unsuitable for reproduction and must be coated with epoxy, sprayed metal, plaster of Paris, or other viscous material to provide a hard unbroken surface for subsequent reproduction. Fortunately the coating, which must be a hard material to obtain an adequate surface, also adds considerable rigidity to the weaker foams.

Porous materials used for molds include interconnected cellular rigid foams or epoxy-metal fiber constructions made by a pre-coating process. The porosity of these materials is excellent for obtaining air flow over the entire surface, but the surface of porous materials is rough and must be coated. This removes the gain of overall air flow, but some consolation is derived in that it is easy to punch or drill holes through the thin shell, and no back drilling with a larger sized drill is necessary. The forming of a sheet of high-density polyethylene over the porous structure is a unique technique for covering the surface. Polyethylene sheet is especially suited to this application since it requires many vacuum holes to form it and the porous mold surface provides the necessary holes. The polyethylene is left on the mold and suitable holes pricked through it for vacuum forming styrene, vinyl, or other dissimilar materials. Of course, the sheet materials can be in reversed order to include other thermoplastic materials.

### Spray metal alloy

Metal alloys in the melting range of 140—170°C. (284° to 338°F.) can be sprayed to coat or build up a surface. Compositions of the alloys include lead, tin, bismuth, zinc, and cadmium. A typical alloy used is "Cerrocast" from the Cerro de Pasco Sales Corp. The metal alloy is kept at a molten state in a hot pot, then sprayed with compressed air. It solidifies immediately

# Trademark of Chemical Development Corporation; Danvers, Mass.
## Trademark of Dow Corning Corporation; Midland, Mich.

on contacting the surface of the object being coated. Heat does not build up because the particles are small and cool quickly after deposition. Therefore, plastic parts are suitable for reproduction because they can withstand the small amount of heat transferred. The alloy is sprayed onto a doll's face, for example, and built up to about a 1/8-inch thick layer. While reproduction of the doll's face is excellent, the air side of the mold made by this spray technique is very rough and generally unsuitable for any mold. Low melting alloys are brittle and, therefore, it is recommended that they be backed up with plaster of Paris ("Ultracal 30") or epoxy (Bakelite ERL-2774 Bakelite ZZL-0820†). Copper coils can be embedded against the alloy before the backing is cast, as is common practice on commercial operations.

### Porous metal

Nickel, bronze, and aluminum powders can be pressed under tremendous loads to obtain a solid but porous sintered material. The Corning Glass Works offers nickel which is specifically designed for use in transferring molten glass, but may be used in molds for plastic fabrication. The bronze sintered products are classified as bearing materials where lubricating oils or graphite are introduced, and as filter material where a higher porosity is obtained. The higher porosity materials are necessary for mold use, especially with larger-sized cavities (>1 ft.$^3$) where a substantial amount of air must be transferred through the mold. Also available are porous metal molds made by undisclosed processes which do not use great pressures. These porous materials, which are generally made to the exact mold size, are being introduced for the thermoforming field.

Blow plates for transferring air by pressure or vacuum have utilized the porous structure of bronze. Machining can be accomplished with sharp cutters, fine feeds, and high speeds (200 fpm.) to obtain only a slight loss in porosity at the surface. The surfaces are limited to a matte finish, but in many cases, glossy surfaces can be sacrificed in favor of the overall holding power of the sheet to the mold. This is especially true with high-density polyethylene. Since it is a disadvantage to put numerous small holes in a mold, porous materials eliminate this problem.

† Bakelite is a registered trade mark of Union Carbide Corporation.

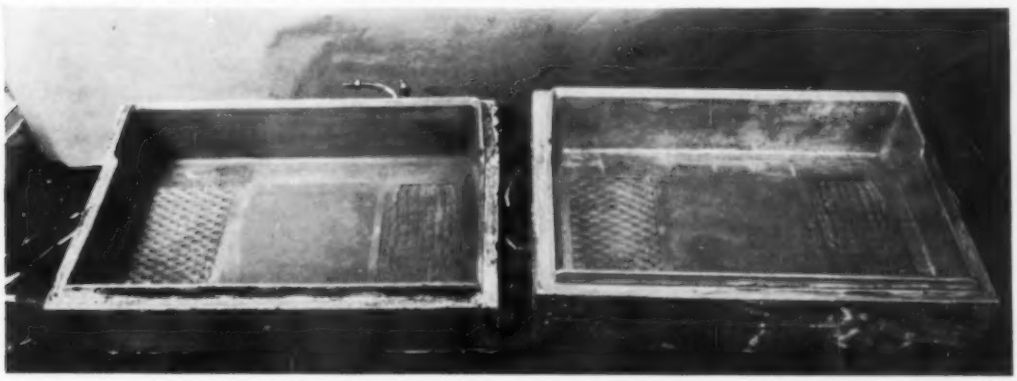
### Epoxy

Epoxies are suitable for thermoforming molds, and have been used in numerous other forming, stamping, and swaging operations where great abuse is experienced. Among the advantages of epoxy molds are toughness, versatility, excellent reproduction, and ease of fabrication. The main disadvantage is low thermal conductivity, which will be discussed in a later section. If a prototype mold must be reproduced from a master or an already formed part, epoxies are extremely applicable. Various product combinations have been used because of their availability, adaptability to fabrication technique, toughness, transparency, heat distortion point, and required curing procedures. The chemical resistance, weathering, and electrical properties of these materials are not a factor in their selection.

Epoxy resins are skin-sensitizing agents, and proper handling precautions must be observed with their use. In handling epoxy resins and hardeners, personal contact by the individual should be avoided through the use of rubber or vinyl plastisol gloves, goggles, and protective clothing.

While numerous resins are available, Bakelite ERL-2774 (diglycidyl ether of bisphenol A) was chosen for its compatibility with numerous hardeners and its availability. Bakelite ZZL-0814 (aliphatic amine ethylene oxide adduct) and other room temperature curing, nonhazardous hardeners can be used for spray techniques, hand lay-up procedures, or when casting in very thin sections. It is most desirable to use an aluminum powder with the epoxy to help dissipate the exotherm. In order to ensure greater success with larger castings, it is not recommended that aliphatic amine hardeners with short pot lives, excessive exotherm in thick sections, and lower heat distortion temperatures be used. Instead, Bakelite ZZL-0820 (modified eutectic of aromatic amines) mixed with ERL-2774 (1 to 5) provides low exotherm and a high heat distortion (140° C.) casting. Thick sections can be cast and filled with up to 50% aluminum powder to decrease exotherm build up. Pot life is 70 minutes at 50° C. The viscosity of this hardener is high, thus increasing the air entrapment and requiring a gel to be applied to the mold surface before casting.

ERL-2774/methyl "Nadic" anhydride/benzyl dimethyl amine (100/99/0.4) is a lower viscosity system which cures to an amber transparent casting. The



Green sand foundry pattern fabricated from Bakelite Epoxy-Alloy EA, an aluminum fiber-filled epoxy formulation.

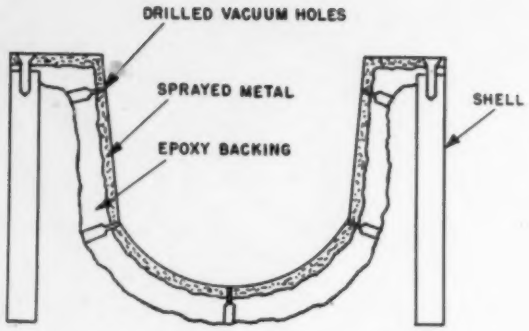



Fig. 1. Mold with backdrilled vacuum holes.

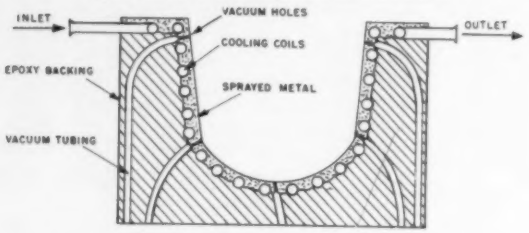



Fig. 2. Mold with cooling coils and vacuum tubing.

gel coat is eliminated, and a two-week pot life at room temperature permits complete removal of air. A pinhole-free mold is required, and the heat distortion temperature (115° C.) and toughness are not as high as ZZL-0820. Methyl "Nadic" anhydride is made by the National Aniline Division of Allied Chemical Corp.

### Silicone casting compounds

Silicone casting compounds are available in a variety of hardnesses ranging from 20 to 90 Shore Durometer A. Room temperature curing conditions make it easy to work with these products. Plug assists and portions of molds and plugs where undercuts and resilience are needed can readily be made to the form desired. High heat resistance (600° F.) permits resistance wiring to be cast into the desired shape to obtain good temperature distribution on the surface of the mold. The surface finish can be varied, depending on the item being used to form the casting. Excellent release from most materials is assured, yet primers and adhesives are available when silicone sections must be bonded.

### Summary

Summarizing the suitability of these materials for mold construction, wood and ceramic materials have the shortest life, yet tend to be the simplest and quickest to fabricate. Epoxies, foams, and other resins have greater durability but the heat buildup shortens their use, as in wood and ceramics. This heat buildup can be lessened by composite structures and insertion of cooling coils. Metals, both porous and solid, have the longest life. Aluminum and copper alloys provide the best heat transfer. Machined, cast, or sprayed metals are all in the upper range of durability and heat transmission properties. The cost of these mold materials is proportionate to their durability and selections must, at times, be a compromise.

## Temperature control and thermal conductivity

Heat dissipation problems with mold materials dictate the need for temperature control. The following experiments were conducted to define these requirements and investigate techniques of temperature control.

A number of small, male cake-pan molds were fabricated from the following materials:

Epoxy, ERL-2774/ZZL-0820 (5/1) 100° C. oven cure
ERL-2774/ZZL-0820 (5/1) 150° C. oven cure
ERL-2774/ZZL-0814 plus 40% Aluminum Powder ("Alcoa" #101) (41) room cure
ERL-2774/ZZL-0814 plus 40% Aluminum Powder (4/1) 70° C. oven cure
Methyl Nadic Anhydride System 105° C. oven cure
Methyl Nadic Anhydride System 160° C. oven cure
"Metalset A-4" (Commercial epoxy patch kit) 100° C. oven cure
"Metalset A-4" (Commercial epoxy patch kit) 150° C. oven cure
Sprayed metal alloy (60% Tin, 40% Bismuth)
General purpose plaster of Paris
"Ultracal 30" (hardener modified plaster of Paris)

The molds were mounted and evaluated simultaneously by drape forming 0.050-inch extruded sheets of Bakelite high-density polyethylene (0.96 density, 0.2 melt index). Continuous production cycles provided estimates of service life and direct comparison between materials. Heater temperature of 1,000° F. (95-105 seconds) was required to heat the sheets, and the cooling cycle with vacuum applied was 55 to 65 seconds. Roughly 30 seconds was allowed between cycles for loading, removal, and inspection except every fifth cycle, when a five minute interval was needed for temperature measurements. The mold temperatures were recorded with a butt thermocouple on the surface (in the center of the top flat area).

The results shown in Table I confirmed the long suspected fact that the room temperature epoxies (ERL-2774/ZZL-0814) do soften as opposed to the high heat distortion type. While there was no melting away, the softening allowed loss of detail, especially where there was more pronounced abrasive action or compression on the contoured areas. The plaster of Paris dried and cracked and the sprayed metal had enough of a non-homogeneity to weaken and fail after a number of exposures. The sprayed metal should be backed up with plaster of Paris, epoxy, or other tough resins.

Temperature must be controlled to eliminate the heat building which causes mold failure and poor thermoformed pieces. A number of techniques for improving heat transfer have been developed. Temperature control coils were embedded in various epoxy materials which had been modified to improve their conductivity coefficients.

The epoxies are poor conductors with coefficients starting as low as $5 \times 10^{-4}$ cal (sec) ($cm^2$) (°C/cm.). By filling with aluminum powder, the coefficient was increased five fold, but this is still negligible when compared to a good conductor such as aluminum ($4{,}900 \times 10^{-4}$). Cetal fibers greatly improved heat transfer as determined by experiments on epoxy alloy, sprayed

Table 1
Stability of thermoforming molds

| | Temperature ° C. | | | Durometer "A" | |
|---|---|---|---|---|---|
| | 5 cycles | 26 cycles | 38 cycles | at 38 cycles | Failure |
| ERL-2774/ZZL-0820 (5/1) | 58 | 70 | 72 | 100 | Slight detail after 38 cycles. |
| ERL-2774/ZZL-0814 (4/1) | 70 | 81 | 87 | 90 | Slightly softened after 38 cycles. |
| "Metalset A-4" | 58 | 66 | 68 | 90 | Softening at 38th cycle. |
| Methyl Nadic Anhydride System | 59 | 69 | 70 | 100 | Appeared to lose no detail after 38 cycles. |
| Plaster of Paris (General Type) | 60 | 67 | — | — | Flaked and cracked at 3rd cycle. |
| "Ultracal 30" (Hard type of Plaster) | 65 | 72 | — | — | Flaked and cracked at 7th cycle. |
| Sprayed Metal Alloy | 89 | 101 | — | — | Warped at 5th cycle, cracked at 10th cycle. |

Table 2
Thermal conductivities of mold materials
Cal x $10^{-4}$/(sec.) ($cm^2$) (°C./cm)

| | |
|---|---|
| 1. ERL-2795/ZZL-0820 (5/1) capillary casting into precoated and cured blocks of copper and aluminum fibers (34.2% Metal) | 68 |
| 2. ERL-2795/ZZL-0820 (5/1) pressure casting (Epoxy Alloy) with 65.2% of copper and aluminum fibers | 384 |
| 3. ERL-2795/ZZL-0820 (5/1) (Non-filled) | 5-9 |
| 4. ERL-2774/ZZL-0820 (5/1) mixed and cast with 10% copper and aluminum fibers | 24 |
| 5. ERL-2774/ZZL-0820 (5/1) mixed and cast with 50% copper and aluminum fibers | 87 |
| 6. ERL-2774/Methyl Nadic Anhydride system cast with 10% copper and aluminum fibers | 43 |
| 7. ERL-2774/Methyl Nadic Anhydride system cast with 50% copper and aluminum fibers | 73 |

metal fiber/sprayed epoxy systems, and precoated fiber systems. Simpler techniques were sought; therefore, we mixed the same ⅛ - ¼ inch long metal fibers into the epoxy casting systems as you would add a filler. The metal fibers were aluminum and copper, mixed 5 to 3 by volume. Epoxy systems used were ERL-2774/ZZL-0820, and ERL-2774/methyl "Nadic" anhydride/benzyldimethylamine. These metal fiber-filled products and systems are covered by U.S. Patent No. 2,901, 455 assigned to Union Carbide Corp.

Fiber concentrations of 10, 50, and 90% were used, with the higher percentages of fibers providing greater areas for intimate contact. Epoxy viscosity was an important factor with the thin "Nadic" system, where small percentages of fibers tended to settle. With the more viscous ERL-2774/ZZL-0820 system, high percentages of fibers could not be mixed in within a reasonable time.

The conductivities of these cast mold samples, along with other fiber-filled systems, are listed in Table 2. Unless otherwise noted, the tests were made via a simplified procedure for heating the bars from one end and comparing them to stainless steel, Type 304, as the reference material. This test is the modified Ingen-Hausz method described in the book "Practical Physics" by M. W. White, et al, 1955, which is applicable to low conducting materials. The increase in conductivity with increased fiber content should be noted. Also of importance is the casting technique, which provided conductivities in the same range as the sprayed and pressureless cast samples. This simplified fabrication of cast molds which have coils embedded for a more positive temperature control.

## Fabrication Techniques

Prototype preparation is not complicated in most cases. As mentioned previously, an already formed part which can be sprayed with epoxies or metal; cast with epoxies, metal alloys, plaster of Paris, or elastomers; or hand troweled with epoxy, epoxy/glass cloth, or plaster of Paris is recommended. If no prototype exists, it must be made.

### Spraying

Several fabrication techniques are involved: A simple back-drilled mold is illustrated in Fig. 1. Sprayed

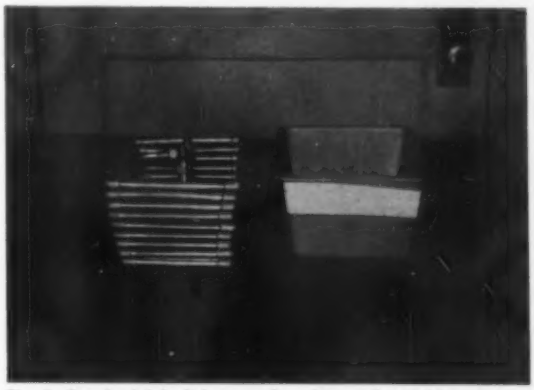


Fig. 3. Standard lab dishpan and cooling coils. Mold to feature plug assist.

Fig. 4. Gel-coated pan with coils installed.

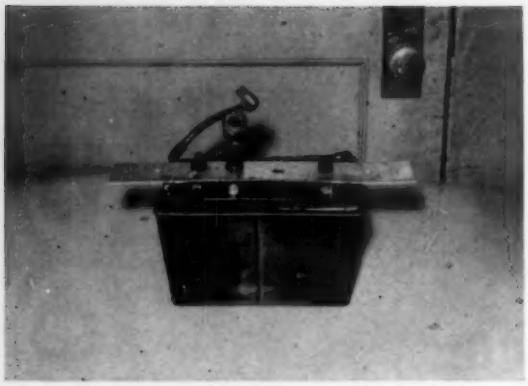


Fig. 5. Lock-up with epoxy poured and curing.

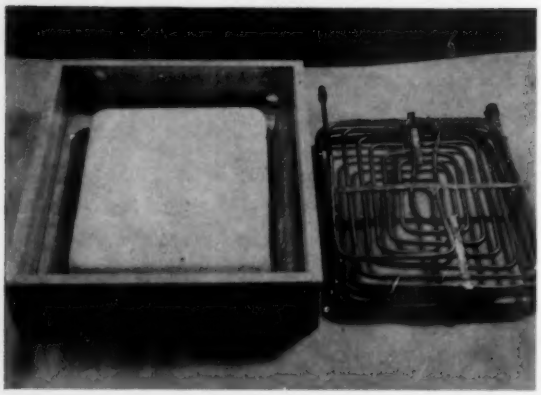


Fig. 6. Cast epoxy tray mold with embedded copper coils, separate here.

metal was built up to about ⅛-inch thickness and then backed with epoxy for added strength. The holes were drilled and the structure mounted in a frame for support. More complicated contours or molds with cooling coils required other techniques for drawing vacuum as shown in Fig. 2. The small vacuum holes were drilled through the thin shell, then copper tubes were fastened and led to the base area before more reinforcement was added. This tubing arrangement can be replaced with insert pins before spraying, then removed after the mold is backed up. This technique was not used extensively in the laboratory because the more complicated molds are usually made by commercial firms.

The epoxy spraying technique employed was identical to that used for metal spraying, except for a gel coat which was first brushed onto the formed piece to ensure a smooth unbroken surface. ERL-2774/ZZL-0820 was used for the gel coat, because of its high heat distortion temperature. The spray technique was used with metal fibers to improve the heat transfer properties.

## Opaque castings

The epoxies which were cast required a gel coat on the surface unless a low viscosity system was used. Higher viscosity systems (5,000 to 20,000 cps.) presented air entrapment problems which were reduced by drawing a vacuum on the pot and also on the mold after pouring, vibrating the pot and/or mold, and by heating the mixture slightly.

The room temperature curing systems were cast when limited to very thin sections. Aluminum powder was included to dissipate the exotherm. The ERL-2774/ZZL-0820 system developed very little exotherm, but required additional curing to gain a high heat distortion temperature. Where the mold being formed had to withstand heat, it was cured at 66° C. for 2 hours and then given a super cure of 150° C. for 2 hours. Alternately, the mold was cured at room temperature until hard; the original prototype was removed; the cast mold was cured at 66° C. for 2 hours; and then given the super cure.

Figures 3, 4, and 5 show a plug assist made for a mold of the standard molding laboratory dishpan. A gel coat was applied to the inside of the pan, copper tubing was inserted, and the epoxy poured in and cured. During use, the temperature gradient across the surface was very low (1-3° C.) but the conductivity of epoxy was also too low. Casting with metal fibers would improve the heat transfer and allow greater spacing of the tubes.

## Transparent castings

The methyl "Nadic" anhydride (MNA) system has

*(Continued on page 34)*

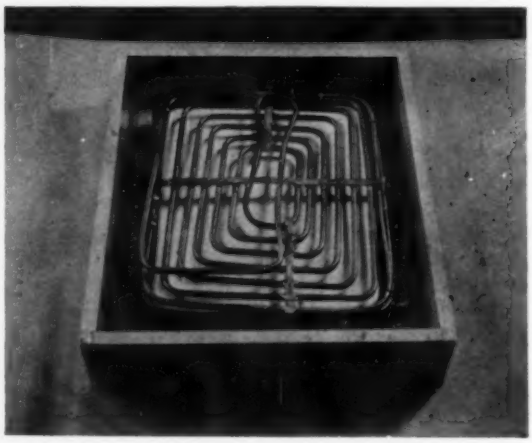


Fig. 7. Coils put over tray with inlet and outlet in box.

Fig. 8. Coils through epoxy as a female mold.

JOHN R. LYNCH*

# Thermoforming—

# processes and applications

**This second half of last month's article by Mr. Lynch covers the machine components and types used, as well as sections on mold construction and design considerations. Among the machine types illustrated are the single-stage forming unit, the roll-fed single, the double-stage, the three-stage rotary, the continuous forming unit, and the drum former.—Editor.**

## Matched die forming

A pair of matched molds form the softened sheet and no additional air pressure is needed. The dies are designed to allow for the thickness of material remaining after forming. They are normally mounted on press platens; the softened sheet is placed on the open mold, and the mold is closed to form the part. If dies are made of a hard material, close alignment during forming is required to keep them properly matched. One die surface can often be foam, which is not cut to the exact contour but simply forces the sheet to conform to the opposite die face (See Fig. 13).

## Cooling

Probably the longest phase of the forming cycle, cooling may be from the mold side by conduction and from the opposite side by convection. When molds are properly cored for temperature-controlled water, most heat can be removed through the mold. In cavity formed parts, the cooling rate is further retarded because the sheet tends to shrink away from the mold and heat conduction is lost.

The tendency to hold mold temperatures below 100° F. induces thermal stresses in the formed parts, and 130-170° F. is recommended. Additional cooling from the top side can be obtained with fans or blowers, and are vital if wood, plastic, or plaster molds are used. Water sprays are generally not recommended as they can cause surface spotting. Highly atomized sprays have been used successfully, however.

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Part removal is usually accomplished by building up air pressure beneath the part. Once the part is released, the clamping frame is raised or the mold is lowered to separate the finished item. Stripping may be necessary for drape-formed parts or where there are undercuts. Ejection pins or rings can be mechanically actuated from within the mold or a light grid (framework) can be built onto the clamping frame.

## Shrinkage

This is due to thermal contraction during cooling and to changes in density which accompany crystallization of the material. Most shrinkage takes place by the time a part reaches room temperature; however, the following 15-30 minutes usually produce additional, noticeable shrinkage. There is even some additional shrinkage in the case of very crystalline polymers such as the polyolefins and saran. If close tolerances are to be maintained, the time interval between forming and trimming must remain constant though its length may not be critical. The safest procedure is to maintain an inventory of formed parts which are not trimmed for at least 15 minutes after forming.

Mold shape also affects the amount of shrinkage during cooling. In cavity molds, the parts shrink away freely and maximum shrinkage occurs. With positive molds, especially those with inadequate wall taper, the part is restricted by the mold and shrinkage is hindered. Parts formed on combination molds will vary slightly in their shrinkage patterns. For this reason, parts often vary from the theoretical shrinkage values given for different materials.

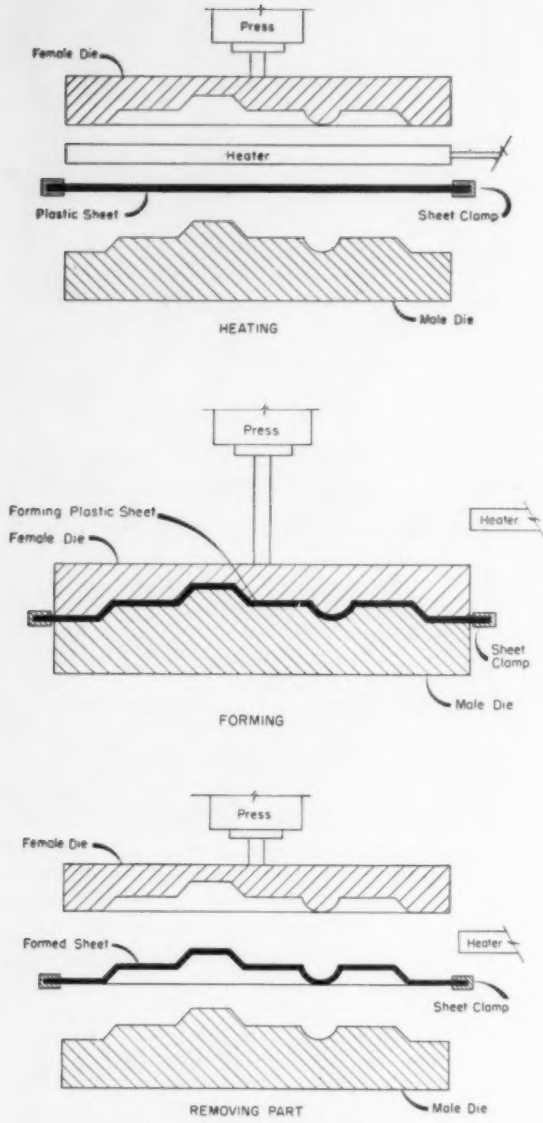


Fig. 13. Matched die forming.

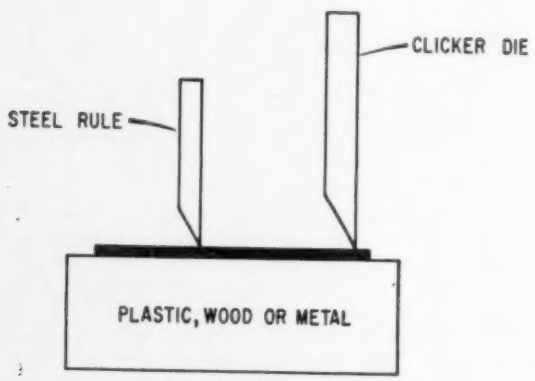


Fig. 14. Cutting dies.

Dies may be single or multiple units depending on size and capacity of available trimming presses and the production rates required. Normally, when cut sheet is used, the trimming die will match the forming mold. A common characteristic to both cutting and shearing dies is the flange on the formed part. When close die alignments are maintained, the flange may be as small as 5 mils. It can also be eliminated by intentionally distorting the part while it is being trimmed.

Planetary trimming allows parts to be trimmed on the side wall leaving no flange. Advantages of this method are relatively low die costs and close spacing in multiple molds. Relatively little power is required, since the trimming is done by a simple shearing operation with very uniform loading throughout an extended cycle. The die consists of two flat plates, one stationary and the other capable of moving eccentrically in a circular path. The part is placed between the upper and lower plate. As the upper late moves around the periphery of the formed article, shearing takes place between the two plates (See Fig. 16).

For some applications, it is desirable to trim the formed part while it is still in the forming mold. One such method incorporates a knife edge around the periphery of the forming die and a movable heated ring directly over the die. After the object is formed in the conventional manner, but before it is cool, the heated ring drops down and presses against the knife edge in the mold. This pinches the part from the web. The same process may operate in reverse by the placement of a heated knife edge on the upper platen and bringing it into contact with the sheet against a flat mold surface. Plastic material may, however, build up on the trimmer and reduce its effectiveness. Shearing dies which either punch a section of sheet or trim the part before it is removed from the mold are also used.

## Trimming

The method of trimming is determined by the type of material, location of the trim line, thickness of the sheet, and quantity of parts to be trimmed. For comparatively short runs, parts can be trimmed along nearly any desired line using band or circular saws, manually or mechanically operated shears, shapers, or routers. If additional finishing is required, a wet (or dry) continuous belt sander can be used. Cutting or shearing dies are commonly mounted in a press for use with long production runs. Steel rule dies used for scoring paper boxes are employed to trim sheet up to 50-mils thick in production runs under 100,000 strokes. These dies are mounted either in an inclined mechanical press or in an upright mechanical clicker press. They cut usually against a softer material such as hardwood or brass. Heavier machined cutting dies (high or clicker) can be used to cut heavier sheet for extended production runs (See Fig. 14).

Matched shearing dies are used for materials under 5 mils to over 200 mils. Tolerances between the punch and die are much closer than are commonly used for sheet metal of the same thickness. For impact styrene, a range of 2-5% in sheet thickness is considered the proper clearance. Retaining clamps are used opposite the punch or die (or both) to prevent bending or breaking. Dies can be mounted in pneumatic, hydraulic,

combination, or mechanical presses. The latter seem particularly suited to shearing dies (See Fig. 15).

## Thermoforming equipment

The equipment used in sheet forming can be built up from basic components to any degree of complexity. The basic machine, capable of straight forming, would have the following parts: heater, vacuum pump, accumulator tank, vacuum line and valve, mold table, and supporting framework. The latter would include a sheet clamping frame.

Many forming machines have advanced far beyond this elementary stage and are capable of production operation with automatic cycle control, using a variety of forming techniques. These machines have such additional features as a movable lower platen or clamping frame, a movable upper platen, movable heaters or sheet carriage, air pressure systems for preballooning sheet and ejecting formed parts, vacuum bleed-off systems for control of ballooning during plug assist or air-slip forming, and necessary controls for each component of the system.

## Machine types

In addition to the essential elements, there is a wide variety of material-handling devices for loading and unloading sheet, or indexing roll stock and moving it through various phases of the forming cycle. These machines can be further combined with equipment for trimming and with such packaging features as product loading and heat sealing to a paper backing. Such machines are often classified by their methods of materials handling or by the number of operations they can perform simultaneously.

A single-stage machine can perform but one operation at a time, and its total cycle is the total amount of time it takes to load, heat, form, cool, and unload (See Fig. 17). Most operate from sheet stock; however, some are equipped with a roll feed mechanism which indexes the roll stock after each cycle. These mechanisms eliminate most load-unload labor and, in a sense, make the operation continuous. Any material can be used which is flexible enough to be rolled on a core. Heavier sheet can be roll fed if heaters are used to soften the sheet as it unrolls (See Fig. 18).

Another variety of single-stage machine is capable of contact heating and pressure forming. It is especially suited for use with oriented polystyrene, although it can be used to form most materials. One type is fed from precut discs, the other from roll stock. The units are particularly suited to preprinting and detailed forming of shallow articles such as container lids.

A double-stage machine performs two operations simultaneously. Such a unit usually consists of two forming stations and a set of heaters which move between stations (See Fig. 19).

Three-stage machines are usually built on a horizontal circular frame, and are referred to as rotaries. Loading-unloading, heating, and forming-cooling are performed as simultaneous operations with the machine indexing 120° after each operation. Such machines are used extensively for sizeable production runs on large area parts such as refrigerator inner door liners, food chest compartments, etc. (See Fig. 20).

A fourth stage may also be added to accommodate a trimming press. The circular frame would then be divided into 90° segments.

Another machine which is playing an increasingly important role in thermoforming operations is the continuous forming unit. It is designed for high volume operations and seems particularly well suited to the

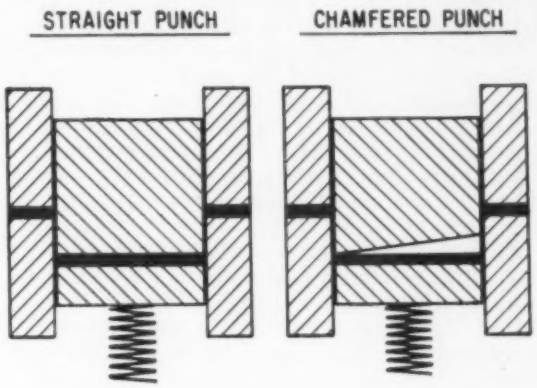


Fig. 15. Shearing or blanking.

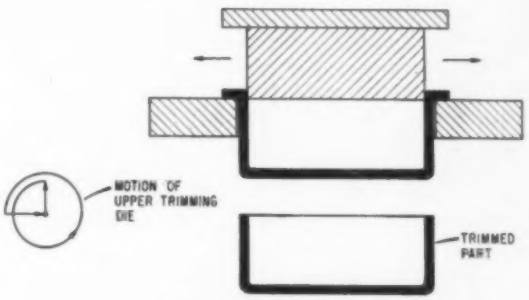


Fig. 16. Planetary trimmer.

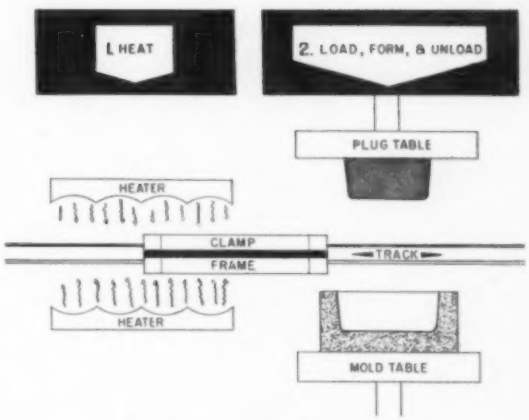


Fig. 17. Single-stage forming unit.

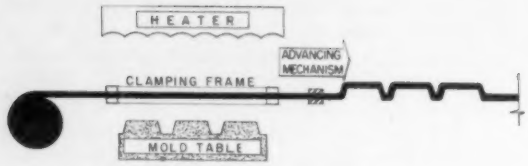


Fig. 18. Roll-fed single-stage unit.

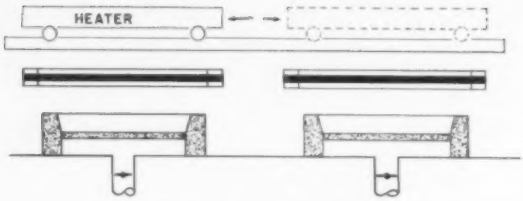


Fig. 19. Double-stage forming unit.

packaging industry. Such a machine can be operated directly from an extruder or from roll stock because sheet movement is continuous and speed is constant. The sheet may retain its heat from the extruder or, with roll stock especially, may receive additional heat by passage through a heating section.

There are two types of continuous forming units. One utilizes conventional molds which travel horizontally at the same speed as the sheet; the other, a rotating cylinder for the mold. The latter is often referred to as a drum former.

With the horizontal unit, the sheet is clamped at the edges and moves at a controlled speed. The mold and plug table move with the sheet, but have a reciprocating motion so that they can index to the next unformed section of sheet once the forming cycle is complete. This type unit is suitable for any of the common forming techniques. (See Fig. 21).

The drum-type former uses either flat or curved mold sections attached to a rotating cylinder. The sheet is held only at the edges, or is simply draped over the drum unless a special indexing clamp frame is used for each row of parts. The hollow center of the cylinder must be sectioned so that vacuum can be applied at a fixed position in the mold as the drum rotates. With straight-walled cavity molds it becomes increasingly difficult to strip the web from the mold as the drum diameter decreases. To avoid a binding action on such parts, they must be trimmed individually or in rows before being ejected from the mold (See Fig. 22).

## Molds

One of the biggest advantages of sheet forming is the variety of materials which can be used for the molds, and used satisfactorily! In vacuum forming, they

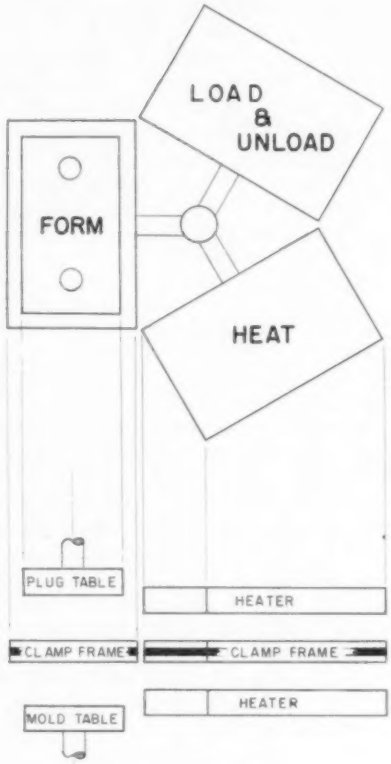


Fig. 20. Three-stage rotary unit.

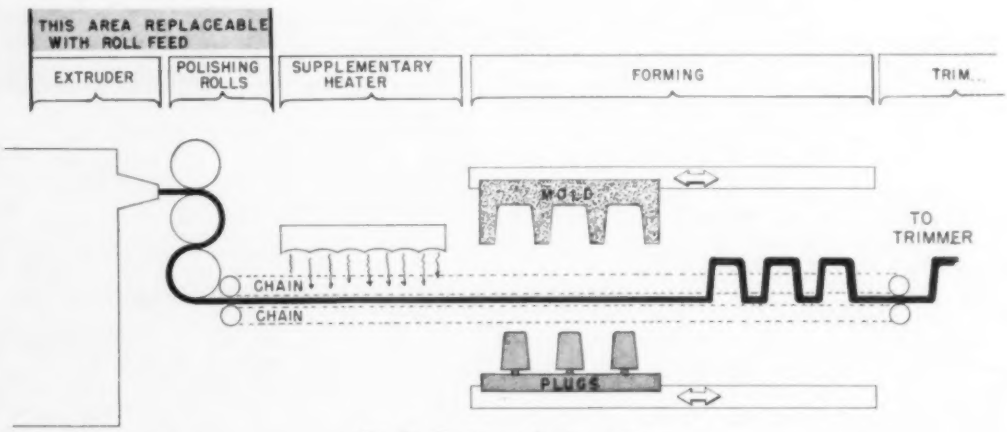


Fig. 21. Continuous forming unit.

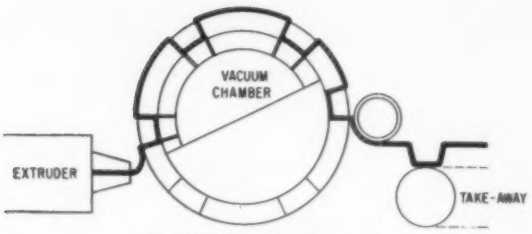


Fig. 22. Drum forming unit.

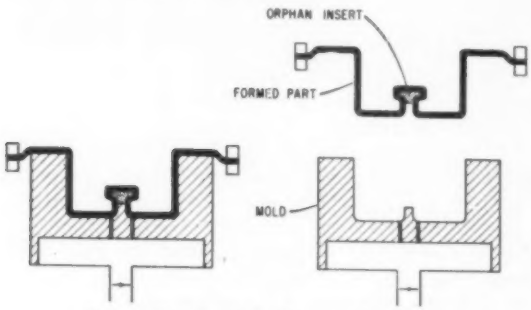


Fig. 23. Part formed with an orphan insert.

need only to withstand 14 psi.; therefore, minimum strength is required. If pressure forming is used, molds must resist up to about 300 psi. without deflection. Wear on molds is negligible, since there is little flow of the plastic material against the mold surfaces.

Many materials are available for making molds to be used in vacuum forming. These include wood, plaster, thermosetting plastics, and metals. Wood and plaster are usually limited to short runs or prototype preparation since they tend to chip and break with extended production. Plastic molds are also used for short runs and sample preparation because they are easily molded; however, they have sufficient strength for extended production as well. The major difference between plastic and metal for production molds is the difference in thermal conductivity of the two materials.

### Mold construction

Typical forming molds have a series of vent holes located in those areas where the sheet will be formed last. In vacuum forming, they project downward into a common chamber at the bottom of the mold. In constructing molds, here are some fundamentals which should be observed:

1. If possible, avoid flat surfaces since a slight dome or dish effect will allow the sheet to stretch over the entire surface. This prevents minute bumps which sometimes appear in flat sections.

2. Maximum allowable diameters for vent holes will vary with materials and sheet thickness. For impact styrene in thicknesses greater than 0.060-inch, holes up to 0.030-inch in diameter can be used. For thinner sheet, especially where both sides of the part will be seen, it may be necessary to reduce hole diameters to 0.010-inch to avoid hole marks. Polyethylene formed parts exhibit more severe hole marking, and it is usually necessary to hold the diameter under 0.020-inch regardless of sheet thickness, and at 0.010-inch for thinner gages. It is often possible to split molds, leaving a 0.010-0.015 inch wide slot which may extend around the entire part. The slot will allow greater passage of air and will exhibit no more of a vent mark than a hole of comparable diameter.

3. Holes should be back drilled to approximately 0.01-inch or less from the mold surface to minimize restrictional flow.

4. The number of vent holes depends on the desired rate of drawing. It is usually desirable to form as rapidly as possible, so an ample number should be provided. With a combination mold which has several cavity sections, such as a refrigerator door liner, it may be desirable to increase the ratio of holes to chamber volume. This enables you to evacuate a deep chamber more rapidly than an adjacent shallow section. Rapid plug-assist forming will require an appreciable increase in the number of vent holes.

5. Holes should be located in those areas into which the sheet will be drawn last. In parts where fine detail or textured patterns must be produced, vent holes less than ½-inch apart may be necessary.

6. If undercuts are involved, there are five basic techniques used to aid in the removal of parts from the molds: (1) split section molds may be disassembled to remove the part; (2) hinged sections which unfold as the part is removed may be used for straight line undercuts; (3) mechanical strippers built into the mold may be incorporated to provide positive mold release for parts with slight undercuts, especially in high speed production (containers made to accommodate snap-on lids); (4) protruding sections which are cam-actuated may be withdrawn into the mold before the part is removed (cams are usually actuated by air cylinders mounted within the mold base); and (5) a portion of the mold may be built so that it is easily removed and remains as an orphan insert in the finished part. Such

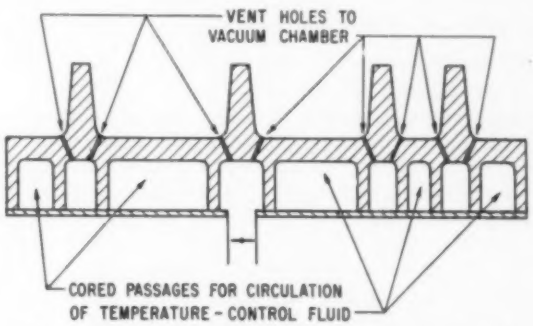


Fig. 24. Cast aluminum mold cored for temperature control.

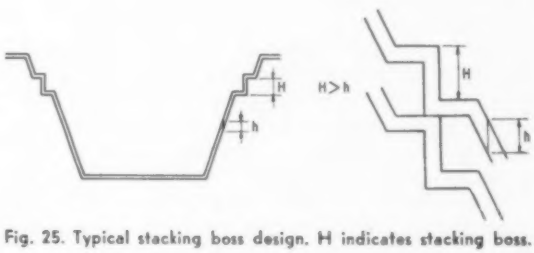


Fig. 25. Typical stacking boss design. H indicates stacking boss.

inserts are held in place by an undercut, preferably of the same material so that there will be no difference in thermal expansion and contraction (See Fig. 23).

7. Production molds should be cored so temperature control water can circulate freely through the mold base. For combination molds with high ridges, it is often advisable not to core these ridges completely so the upper section will operate at a higher temperature than the remainder of the mold. When tubing is cemented to the bottom of the mold, there is little problem with leaks between the vacuum chamber and the cooling system. If molds are cored for water, proper vacuum channels are required. Usually, such molds are built with alternate channels for air and water or with an upper and lower section. The upper section contains the water channels; the lower, a vacuum chamber. Vacuum holes are drilled through the casting in areas that are not channeled and connected to the vacuum chamber (See Fig. 24).

### Design considerations

Parts should be as free as possible from stress concentration or susceptibility to stress during normal use. Design plays a major role in minimizing stress. The fabrication technique involved determines the design, and choice usually means a compromise between the most favorable technique and the limitations of available equipment. Once chosen, the fabrication method will set certain limits on the part design.

Parts formed over positive molds must have ample wall taper for release from the mold. Generally, 3° are minimum for side wall draft. As the distance across the top of a positive mold increases, the total shrinkage is greater. It is, therefore, preferable to increase the degree of wall taper to allow the formed parts to slide readily up on the side walls as they cool and shrink.

Sharp corners cause stress concentration; therefore, the largest possible radii and fillets are desirable. Some materials are difficult to draw into corners if the radius is less than twice the sheet thickness. Avoid notches or square holes when punching formed parts. Round holes are best, and preferable to oval holes for minimizing stress concentrations.

Ribs may add rigidity to formed parts when placed parallel to the direction requiring it. Generally, several small ribs are superior to one large one, as the greater distance from the neutral axis to the outside surface will build up greater stress. If a formed part must flex a predetermined amount because of excessive loading, ribs are usually eliminated to minimize internal stress build-up. Proper design calls for a balance between stiffness and flexibility, and the load should be distributed throughout the part rather than on a single flange or rib section.

It is often necessary to stack formed parts together, with controlled spacing between units. If allowed to jam, the wedging action can induce high stresses within the parts and cause them to split. To avoid this, a stacking boss or shoulder can be incorporated in the part. It consists of a vertical or undercut portion on the side wall which will interfere with a similar boss in the units above and below.

Bosses should be formed distinctly, and there must be a sharp break at the bottom and top of the vertical section. The height of the stacking boss must be greater than the vertical cross section of the formed unit at the point of least taper. Otherwise, tapered walls will interfere before the stacking sections engage each other. These sections may be placed at the top or bottom, or anywhere along the side wall of the formed unit. However, the container must be rigid enough in this area to prevent the bosses from deflecting and allowing the units to jam (See Fig. 25). Stacking bosses are most critical when used in packaging work, especially on formed containers which must be run on automatic vending or dispensing equipment. —The End

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**Prototype and mold fabrication**

*(Continued from page 28)*

also been used for its low viscosity, plus high heat distortion and semi-transparency in the cured state.

This transparency is desirable because it showed any air bubbles left in the mix which were then removed before curing; inserts or heat transfer coils were located to prevent drilling the vacuum holes into them; forming action as the sheet draws down was observed and any irregularities in cycle times, temperature differentials, or mold design were corrected; and plug assists were observed for alignment and depth adjustment.

Castings were gelled at 70° C. This required 20 to 40 hours, depending on the size of the mold. Post curing for 4-6 hours at 110-120° C. tended to darken the casting, but provided good toughness and a higher heat distortion point. It was found desirable to leave the prototype in the mold being cast as long as possible during the curing cycles and to maintain a slow cooling rate (overnight) to minimize warpage.

Figures 6, 7, and 8 show a transparent, cast epoxy tray mold with embedded copper coils. In Figure 6, a photographic tray is in the box and the coils are separate. Figure 7 shows the coils put over the tray with the inlet and outlet extending through the box. Finally, the view of the cast piece in Figure 8 shows the coils through the epoxy as a female mold. This MNA system was not as tough as the ZZL-0820 system and cracked when exposed to excessive thermal shock.

## Conclusion

The numerous materials available for mold construction in the laboratory have a wide range of performance and service life and, for the most part, are selected for economy, workability, and speed. Performance and service life are generally proportional to the amount of money and effort expended. If short runs and light loads are expected, wood, plastic, epoxy, etc., will suffice. However, for longer service life, metal is required. Heat dissipation problems dictate the need for temperature controls. —The End

DALE AMOS*

# What's the future of your company?

**Based on remarks made by Mr. Amos before the SPI Custom Molders Workshop, the future is pretty uncertain. Molders are selling machine time, not engineering ability. A new look should be taken to future markets, looking for new applications for plastics. Custom molders would do well to consider proprietary items, keeping an eye on captive operations.—Editor.**

I do not agree 100% that a custom molding company has a future, but I do think that now is the time to take a good look at ourselves and see what our potential will be. The main thing wrong with our industry today is—we are not making any money!

Why aren't we making the money we should? Some are, but they are usually molding specialized applications for a given field and have developed their own specialized techniques for doing a superior job. But the old idea of plastics being a glamour industry has gone by the boards. We are no longer riding the gravy train.

We have grown up—but, we don't act like it! All we do is see how hard we can make it for our competition and how difficult we can make it for ourselves. If you look at plastics sales statistics, you find rising sales trends every month. Yet, we go out and cut our competitor's throats and, as a result, cut our own.

If you approached a banker or financial advisor and told him what the plastics industry did as compared to what other industries do, I am sure he would advise against putting your money back into the plastics industry. You get a 10% gain per year on a closed-end trust. Can you get this in plastics? Not with the 1.7% we are talking about on sales, which probably is three times turned. Who is at fault? It is not the material supplier. It is not the customer—it's us!

We do not want to have happen to us what happened to the metal industry. What, then, must we do? We must first cement our relations with our customers. We must give them the quality and services they require. We must establish in their minds respect for quoted prices and a true sense of total unit costs, not merely a price.

We must know our costs, and engineer our products to the very lowest cost possible. We must quote a price and stick to it. We all think we have friends among our customers. But consider this—I take Joe out, wine and dine him. He's a great guy. You know the rest. He calls up and says: "you know I want you to do this job but, frankly, your tools are a little high and you're about 20% out of line. Perhaps you could check your rates and cycles and see if you can't do something about it."

Every competitor bidding on a job gets the same routine. This continues until someone gives in. What happens? A fire sale! The trouble is we are selling machine time, not engineering or our ability!

Your own salesman is no friend of yours either. He wants his commission, and he wants his volume to go up, and he wants it now. Doesn't anyone build for the future anymore? It is getting to the point where we no longer worry whether or not we get an order. It's a question of how low we want to go. Someone finally gets the price down to below cost and it becomes a question of whether you want to take a 5% loss or a 10% loss, or lose it in overhead. The choice is yours, but it's time to pull the emergency brake. What we can and must do is re-evaluate the future of our business.

I would suggest that a custom molder should apportion at least 15% additional business in industries with which he is not familiar. For instance, if you are molding for the refrigeration industry, diversify and perhaps make casts for golf clubs. We need a change, and this can be brought about in product development. Consider the jobs you are doing today. Someone engineered them. Perhaps not you, but someone had to get out and dig. What helps one, helps all.

But check before you diversify. The market may be

*(Continued on page 38)*

*President, Amos-Thompson Corp., Edinburg, Ind.

E. VAN ANTWERP*

# Equipment for determining low-temperature creep

**Recent test programs proved the stability of glass-reinforced laminates at ambient and elevated temperatures. Before these laminates can be used in such applications as aircraft, the effect of low temperatures on their properties must be determined by stress-rupture tests. Equipment for making stress-rupture tests at temperatures from room temperature to −30° F. is described.—Editor**

In our study of glass-reinforced plastics as substitutes for metals, initial testing was made at elevated temperatures to determine their stability under long exposures. Several investigators have recently released data which indicates that the long time properties of these materials are satisfactory at ambient and elevated temperatures.

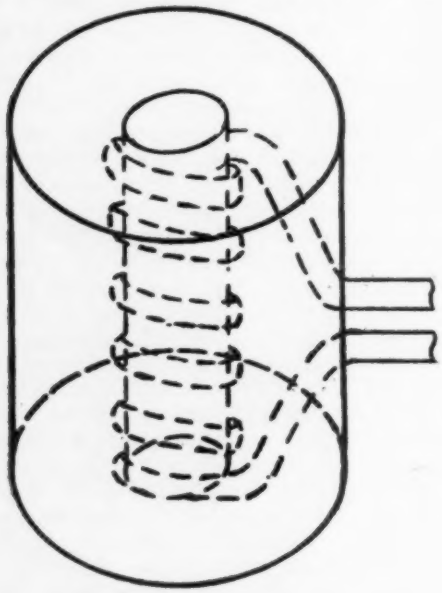

Figure 1. Cold chamber used to cool specimen.

There is practically no information available on the low-temperature creep properties of plastics. For this reason, further testing is necessary. Stress-rupture testing has proven an effective method of evaluating the long-time properties of these materials at elevated temperatures, but additional tests at low temperatures are needed to complete their evaluation.

This article deals with the development of apparatus necessary to perform these tests at temperatures from room temperature to −30° F. Exploratory tests were made on specimens of glass-reinforced laminates to establish the characteristics of the equipment.

A testing machine manufacturer offered to supply the refrigeration and control equipment necessary to adapt one of the conventional springload machines for these tests, but the cost was prohibitive. For this reason, it was decided to develop the apparatus in the laboratory. Careful consideration of the problem indicated that the best solution would be to adapt some of our lever-load machines. These machines were designed to test plastics, and the specimens are gripped outside the test chamber. By removing the grips from the test chamber, less heat would have to be removed in order to attain test temperature because the relatively massive grips would not need to be cooled. Since glass-reinforced laminates have very little elongation, a minimum of lever arm travel was encountered.

To attain the desired low-temperature, a cold chamber illustrated in Figure 1 was made to replace the conventional furnace. This chamber is cylindrical, 8 inches in diameter, and capped with ½-inch transite board. Because flat specimens were to be used, the conventional round core was replaced by an elliptical one. This provided better temperature distribution. The elliptical tube was formed by compressing a 1-inch copper pipe to ¾-inch on the small diameter. This tube was wound with a cooling coil of ¼-inch O.D.

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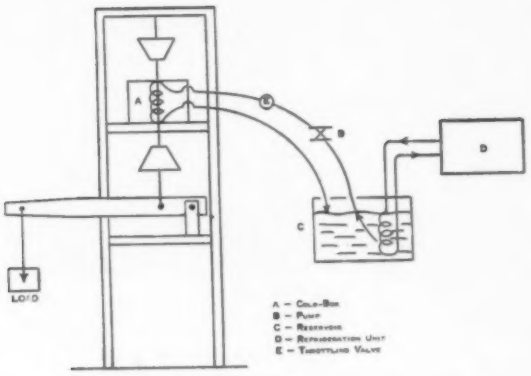


Figure 2. Line drawing of test setup.

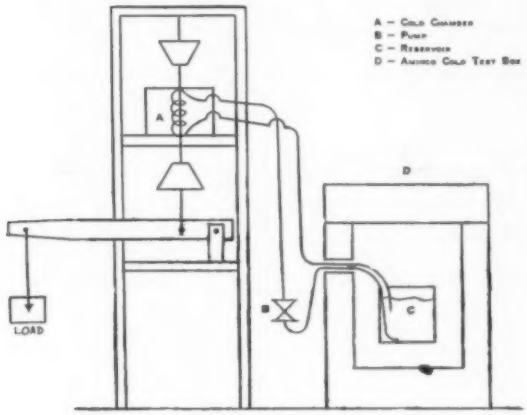


Figure 3. Test setup using dry ice to chill coolant.

copper tubing. The cold chamber was filled with vermiculite insulating material.

Two plans for maintaining the temperature of the cold chamber were considered. The first involved connecting the cooling coil directly to a refrigeration unit. This method would maintain the desired temperatures, but several problems were evident. First, it appeared that the close temperature control desired would place too heavy a demand on the compressor motor, causing frequent breakdowns. Second, the mobility of the cold chamber would be seriously restricted, thus impeding the removal of broken specimens and the setting up of new ones for test. Third, the circulation of a gaseous refrigerant through long tubes would be very inefficient. Since the desired temperatures were not extreme, this plan was considered impractical and was discarded.

The second plan for maintaining the temperature of the cold chamber involved the circulation of a liquid coolant through the cooling coil. To do this a reservoir of coolant was cooled by means of a refrigeration unit. The flow of coolant was controlled as necessary by means of a temperature controller.

While this method would not cool to as low a temperature as would the first method, it was felt that the desired temperatures could be maintained. The use of a reservoir was expected to reduce the stop-and-go demands on the compressor. By using a liquid coolant, the need for modifying of the refrigeration system was eliminated. This system also allowed greater freedom of movement of the cold box in setting up the specimen for test.

A schematic diagram of this test system appears in Figure 2. The coolant reservoir was a sheet metal cylinder 14 inches in diameter and 23 inches deep. It was housed in a 20-inch-square wooden box 31 inches deep and insulated with vermiculite. The reservoir was cooled by means of a Brunner Portable Refrigeration Unit, Model WCF-X-206F1. Specimen temperature was maintained by controlling the flow of coolant with a Brown Pyrovane controller. This system proved very satisfactory for making two tests simultaneously at —20° F. or a single test at —30° F.

During the initial stages of the work, while awaiting the delivery of the Brunner Refrigeration Unit, a temporary test arrangement was set up. This was done so that testing would not be delayed and to evaluate dry ice vs mechanical refrigeration of the coolant. The system uses an Aminco cold test box, and the ice chamber was filled with dry ice. Otherwise, the system (see Fig. 3) was the same as the one described previously. This arrangement proved quite satisfactory as a temporary system. Temperatures as low as -45° F. could be reached, but as much as 150 pounds of dry ice were required daily.

## Test Results

Tests run using the two arrangements indicate that both systems can produce satisfactory results. The dry ice arrangement is best suited for use when a small number of tests are required and the rupture life of the individual specimens is not more than 100 hours. In this case, the reduction in preliminary work offsets its increased cost.

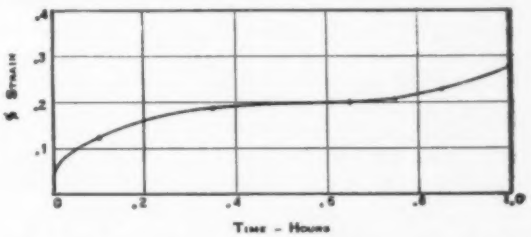


Figure 4. Creep-rupture curve for epoxy-glass laminate at 0°F and 40,000 psi.

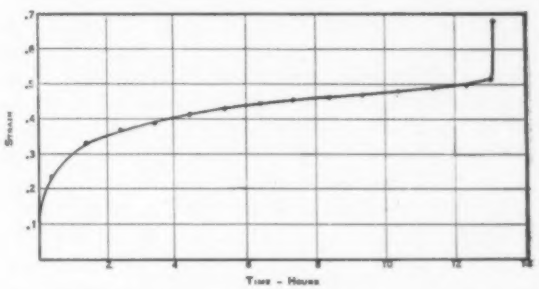


Figure 5. Creep-rupture curve for epoxy-glass laminate at —20°F and 40,000 psi.

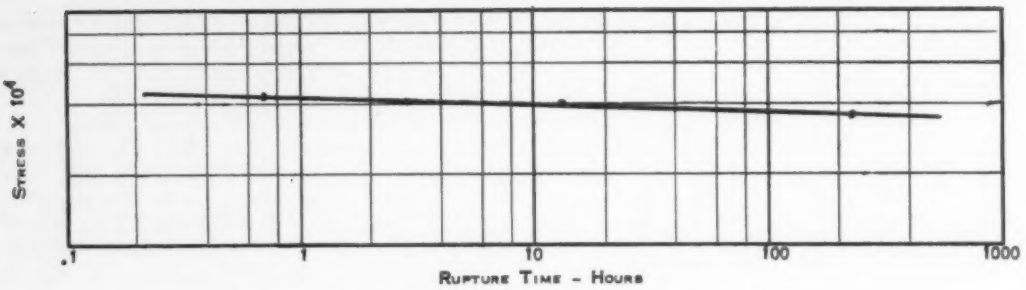


Figure 6. Stress vs rupture time for epoxy-glass laminates at —20°F.

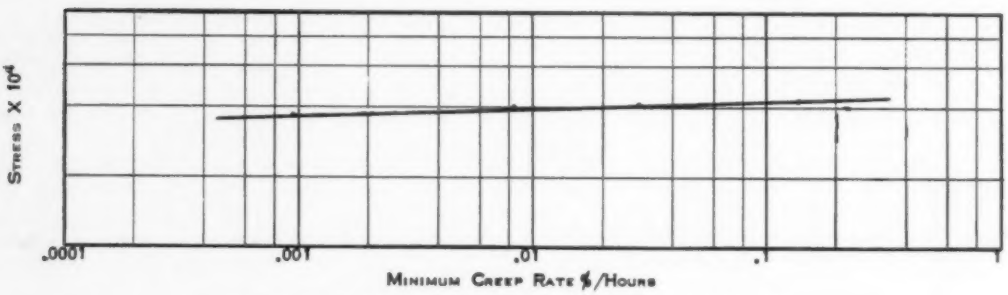


Figure 7. Stress-minimum creep rate for epoxy-glass laminates at —20°F.

When a number of tests are required, the arrangement using the refrigeration unit is more satisfactory. This equipment performed very well and required no maintenance during two months of operation.

With either cooling means, a single-action on-off-type controller maintained specimen temperature within ±2 degrees. Because test loads were high, it was necessary to support the full load on a jack prior to the start of the test and then apply the load slowly.

Although strain measurements are not required in stress-rupture testing, the test machines were fitted to record head travel and the data were recorded. Figure 4 and 5 are representative creep-rupture curves obtained in this manner.

Table 1 summarizes the data obtained on four representative specimens tested for creep-rupture data. Figure 6 is the conventional stress vs rupture life curve of the data in Table 1. Figure 7 is the plot of minimum creep rate vs stress for the same specimens.

Table 1. Creep-rupture data, R5 laminate @ —20° F.

| Specimen Number | Temperature ° F. | Stress, Psi. | Rupture Life, Hours | Min. Creep Rate, %/Hour |
|---|---|---|---|---|
| R5-6 | —20 | 41,000 | 2.9 | 0.02885 |
| R5-8 | —20 | 40,000 | 13.1 | 0.00850 |
| R5-13 | —20 | 43,000 | 0.7 | 0.138 |
| R5-20 | —20 | 36,000 | 229.5 | 0.00095 |

Test data obtained over a two month period indicates that the apparatus described performs satisfactorily in the 0 to -30° F. range. In fact, the representative data presented above indicates that the equipment will provide creep-rupture data on glass-reinforced laminates. —The End

**What's the future of your company?**
*(Continued from page 35)*

seasonal. If I were a buyer of plastics and my requirements were about the same every month, I would not continue buying them. I'd make them. I would save on freight and sales costs. I feel the area for new markets is seasonal business. Toys go for a certain time of the year; so do appliances. What you have to do is balance these seasonal markets in your plant so that you are running efficiently for 12 months a year. Some months, particularly in summer, the appliance firms are on vacation. You may then be running at only 50% capacity if you put all your eggs in the appliance basket. You cannot stay in business this way.

You have to balance your load. Balance it with toys. Balance it with refrigeration. But balance it!

Some of us get weekly business services. Consider some of them. On the left side is the percent return on debt by industry. On the right side is the percent for sales. You will note a lot of variation. The company at the bottom of the chart is going to be a tough customer to deal with. Not so the one at the top. One should service an industry which is profitable in itself. If an industry can't make a dime by themselves, where are they going to get their money. It's going to come out of your hide!

Summing it up, the main thing to look for is your future market. Develop a product for that market; not necessarily a proprietary item, but a new application for plastics. We, in plastics, have a real opportunity in product development. Maybe you should even consider going proprietary, but keep in mind that more and more plants are going captive. Remember, you are digging your grave if you are not building your future. —The End

# Mechanical-acoustical behavior of polystyrene foam

DR. HELMUTH OSKEN*

The cellular structure of polystyrene foam accounts for its interesting properties and for its broadening areas of application (1). Thin cell walls enclosing air within the cells account for the very low specific gravity of polystyrene foam as well as its very low thermal conductivity and high resistance to moisture absorption and water-vapor diffusion. The general technology (2), physical behavior (3), and various applications (4) of polystyrene foams have already been discussed. The present state of the mechanical and acoustical properties of these foams will be reported here.

Foams with open or broken cell walls are interesting from an acoustical standpoint, because of resistance offered to the transmission of sound and absorption of sound in the branched channels. Depending on the cell structure, however, polystyrene foams can withstand relatively high static loads without being permanently deformed. This is the basis for the use of foam blocks, sheets, and panels in the building industry, where compressive, flexural, and shear strengths are important.

Soft foams are valuable for damping vibrations because of their dynamic properties of absorbing energy and decreasing vibration amplitude. Dynamic stiffness, measured in terms of elastic modulus per unit of thickness, is partly due to the air enclosed within the cells. The more the intrinsic stiffness of the cell walls is reduced, the more the overall stiffness approaches the pneumatic cushioning of the enclosed air. Soft, closed-cell foams have a natural resonance frequency which is well suited for sound-absorption applications at a normal angle of incidence. Such foams serve well as a barrier for deadening footstep sounds in concrete floor construction.

## Mechanical behavior

In polystyrene foam production, the tiny beads of expandable polystyrene are first pre-expanded with steam to the desired bulk-density. Then, suitable forms with volumes up to 50 cu. ft. or more are filled with the pre-expanded material, and large homogenous blocks are molded in a second heating step. The blocks thus obtained are cut mechanically or electrically to the desired dimensions. Sometimes, the pre-expanded material is formed into large cylinders from which long foam strips can be peeled.

The process of molding expandable polystyrene becomes more difficult as the density of the block is decreased. Lower density causes lower expansion pressure which usually results in poorer adhesion of the individual particles. This, in turn, can lead to an increase in water absorption. However, excellent foam can be produced at a density of 1.0 lb./cu. ft., which has been well accepted as insulation by the construction industry.

The mechanical properties of polystyrene foam at 1.0 lb./cu. ft. density are also good. Compressive strength is determined by the method of DIN 53421 (1) in terms of load per unit area to cause 10% deformation. An average figure obtained with a 2-inch foam cube is 13.5 lbs./sq. in.

Bending strength is determined by the method of DIN 53423 on samples 4.8 inches long, 1 inch high, and 0.8-inch wide supported on knife edges 4 inches apart, which are loaded to failure. The average bending resistance is about 22.7 lbs./sq. in.

Shear resistance according to DIN 53422 uses cylindrical specimens 2.4 inches in diameter and 0.4-inch thick. A metal cylinder 1.25 inches in diameter is forced against the specimen which is held tightly in a ring. The maximum force required during the test is used to determine the shear resistance, based upon the initial shearing cross section. Average value is 85 lbs./sq. in.

According to DIN 18164, the deformation of polystyrene foam sheet under a loading of 41 lbs./sq. ft. must be determined as a specification test for the use of the foam as a sound deadening layer in concrete floor construction. Fig. 1 shows the percent deformation of various foam samples on loading up to 140 lbs./sq. ft. Up to about 75 lbs./sq. ft., the deformation curve is almost linear and is consistent with the elastic properties of the foam. On releasing the load, the foam expands again to its original thickness, according to

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** Translated and revised by Dr. Charles F. Winans, Resch. Dept., Koppers Co.
# Numbers in parentheses refer to bibliography at end of article.

Hooke's law. Beyond this range a permanent deformation occurs because of rupture of the cell walls. The curves of Fig. 1 show both the possibilities and limitations of foam loading applications, and indicate that the foams are still in the resilient range even after preloading as in concrete floor construction. Under a compression of 41 lbs./ft., the average deformation is about 4.5%.

The dynamic behavior of polystyrene foam is best characterized by its dynamic modulus of elasticity, E, and a convenient method for determining it has been described by G. W. Becker (5). Polystyrene foams with densities near 1.0 lb./cu. ft. give values for E in the range 12—35 kg/cm² (170-500 lbs./sq. in.) with an accuracy of ± 3%. Fig. 2 shows the essentially linear relationship between dynamic modulus of elasticity and frequency for both hard and soft types of polystyrene foam.

## Acoustical properties

The foregoing results indicate that polystyrene foam is dynamically rather hard. From an acoustical standpoint, the resilient properties of the foam have been utilized for the deadening of footstep sounds in concrete floor construction (6), while simultaneously obtaining the benefits of high thermal insulating value and easy application. Fig. 3 shows comparative results in transmission of footstep sounds through a solid concrete floor and through a floor having a polystyrene foam barrier 0.4-inch thick within it. Fig. 4 reproduces two series of measurements on deadening of footstep sounds in recent construction which meet the standard requirements of DIN 52211 (1). Fig. 5 shows the improvement in sound deadening by the use of a polystyrene foam barrier in concrete floor construction as a function of frequency, derived from Fig. 3.

Polystyrene foams have recently been developed in a softer, more flexible form to meet the requiremnts of tentative standards DIN 4109 and DIN 18164 for sound absorping barriers. Fig. 6 shows the behavior of such softer foam sheets with densities around 0.75 lb./cu. ft. on the application of load. These static tests indicate a more linear response in comparison with the results for harder foams shown in Fig. 1. The compression of a soft foam with a density of 0.8 lbs./cu. ft. at 40 lbs./sq. ft. load is about 22%. Measurements of dynamic elastic modulus have given results in the range 1.0—1.5 kg/cm² (14.2-21.3 lbs./sq. in.)

The use of such softer barrier foam layers beneath floating concrete floors gives outstanding deadening of footstep noise. Fig. 7 shows the results obtained when using a sheet of this foam 0.4-inch thick between a reinforced concrete floor 4.75 inches thick and a floating concrete cover 1.4 inches thick. The improvement obtained is shown in Fig. 8 plotted against frequency. Sound absorption is better than expected at low frequencies, but there is a slight decrease in absorption at frequencies above 500, as is also observed with other types of barrier materials.

Soft polystyrene foam not only provides good sound deadening in concrete floor construction, but is also suitable for more conventional sound absorption applications. The harder polystyrene foams, because of closed cell structures, show only slight absorption of incident sound, although improvement can be made, for instance, by needle puncturing and by supporting the foam sheet away from wall or ceiling, as indicated in Fig. 9. On the other hand, soft polystyrene foam shows good sound absorption, and absorbs a maximum of energy when there is resonance between the incident frequency and the natural frequency of the foam.

Absorption of incident sound by a soft flexible polystyrene foam is shown in Fig. 10, where 90% absorption is obtained at the resonance frequency of 1,650. However, the narrow range of absorption, and the high frequency of the peak leave something to be desired. Lower elastic modulus would be helpful. The real possibility of producing a suitable foam, effective from low frequency to resonance frequency, will surely not be overlooked in future developments.

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   DIN 7726: Foam Materials—Definitions—Classification.
   DIN 52420: Testing of Foam Materials—Determination of Bulk Density.
   DIN 52612: Determination of Thermal Conductivity with the Platen Apparatus.
   DIN 52213: Static Determination of Resistance to Flow of Sound Absorbing Materials
   DIN 53421: Testing of Hard Foams—Loading.
   DIN 53423: Testing of Hard Foams—Bending.
   Tentative DIN 53422: Testing of Hard Foams—Shearing.
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—THE END

Fitting plastic panels on sides of new PFE car. Bolts which project through recess in panels and wooden block imbedded in main panel for bolting on retaining strip shown.

# All plastic insulation improves reefer performance

The insulating qualities of Dylite expandable polystyrene of Koppers Co., Inc., and the strength and toughness of Cycolac ABS plastic of the Marbon Chemical Division of Borg-Warner Corp. were combined in a "plastic sandwich" insulating panel for doors on refrigerated freight cars of Pacific Fruit Express in 1960*. They have now been used in a similar manner to provide almost the entire insulation for five newly designed reefers by PFE. Each car contains a total of 28 Cycolac-Dylite panels measuring 42½ inches wide, about 9 feet in length and 6½ inches thick; 22 panels on the sides and three on each end. Insulation on the roof of the cars is Dylite only fastened to plywood. Each of the cars is, of course, equipped with doors having the same Cycolac-Dylite panels first used alone in more than 1,000 reefers operated by PFE in 1960.

The superior insulating efficiency of the skin-foam interior panels enables the cars to maintain any temperature from −10° to 70° F. throughout the shipment of fruit, produce, and frozen foods—a marked improvement in service performance over previous cars.

The new type panels for the walls of these cars were developed by Robert L. Landis, president of Landis Industrial Co., Santa Clara, Calif., and consist of a liner of Cycolac, a backing of ¼ inch plywood, and six inches of Dylite in between. The Dylite polystyrene is expanded to 1½-pound density in the Landis plant. The Cycolac sheets are first vacuum-formed on what is said to be the largest vacuum-forming machine ever built. In forming the ABS liner shell, Landis designed modified S-curve corrugations for the surface, which act as "flues", allowing cold air to flow despite wall to wall loading of closely packed cargo. The formed Cycolac sheets are then placed in a custombuilt press which fuses the Dylite beads within the shell. Within this shell, the Dylite and Cycolac are bonded with a special adhesive which first dries on the outer shell and then is reactivated by the steam used to fuse the Dylite to the shell.

Each of the panels is fabricated with a step-down edge or recess which makes it possible to fasten them individually to the car's exterior steel wall structure. Since the panels are not fastened to each other, a slight degree of independent movement is possible, permitting response to thermal expansion and contraction. Bolts from the outside of the car are fastened in the recesses. Retaining strips of Cycolac-Dylite fit over the recesses of two butted panels and are pulled down to line up with the surface of the regular panels by other bolts which go into wood blocks imbedded in the main panel moldings. This method of assembly prevents any transmission of heat by the steel bolts from the outside to the interior of the car since none of them passes completely through the plastic insulation. Butted edges of the panels and the retaining strips are caulked to make the insulation complete.

The Cycolac ABS panel liners provide unusual resistance to shock and impact at even sub-zero temperatures. They have reliable dimensional stability, offer excellent moisture resistance, and permit substantial weight reduction without sacrificing strength and durability. The use of the efficient Dylite polystyrene insulation results in an economically thin wall, which provides more cargo space (451 cu. ft. per car over earlier models) without requiring an increase in the size of the cars' refrigeration equipment.

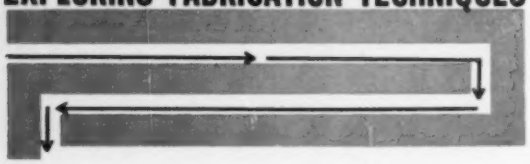
The total weight of Dylite in each PFE car is approximately 1,025 pounds. Total weight of the Cycolac shells per car is about 900 pounds. With the new panel liners providing a smooth, easily cleaned surface, the car's interior presents a marked contrast to the varnished plywood linings of the older reefers along with the many other advantages mentioned.

—THE END

* Plastics Technology, August 1960, p. 57.

PLASTICS TECHNOLOGY

# EXPLORING FABRICATION TECHNIQUES



By L. J. ZUKOR, *ENGINEERING EDITOR*

## Continuous degassing of liquid resins

One of the trickiest problems involved in working with liquid resins is the degassing operation!

Improvements in degassing these resins for casting should be of interest to workers in casting and related fields. The recent development of an automatic continuous degassing unit holds promise of creating significant economies in production operations.

Liquid resin compounds employed in encapsulating electronic assemblies or in other casting processes generally have a rather high viscosity and at some point in their manufacture and use, entrap air, water, or both. It is necessary to process these compounds further to remove these volatiles before the compounds are cast into the molds so that voids or bubbles are not present in the finished castings. Such voids or bubbles lower the electrical and mechanical properties where they occur in the castings and cannot be tolerated, particularly in electronic assemblies used in critical aircraft and missile applications. These voids are extremely difficult to detect, although Western Electric is using a method of test based on the corona discharge principle for solid electrical insulation that might be applied to potted electronic assemblies.

Encapsulators are not the only processors concerned with the degassing or dewatering of liquid resin compounds, however. These problems are the concern of all who work with liquid resins or the liquid components of condensation resin systems (i.e., epoxies, polyesters, etc.) or with polyvinyl chloride plastisols.

Workers with vinyl plastisols found earlier that occluded air could be readily removed by batch deaeration in a closed vessel under vacuum, preferably with slow agitation during the process. This method works well with liquids having viscosities less than 5,000 cps.; other more viscous fluids have been successfully deaerated in the Cornell centrifuge. In this machine, the liquid is drawn into the apex of a funnel shaped rotor where, under a force several times that of gravity, the liquid is spread out in a thin film along the walls of the cone while under a vacuum. The speed at which this unit operates is limited only by the separatory action peculiar to all centrifuges which will separate the liquid mixtures according to the specific gravity of each component.

I recently observed the operation of a new automatic degassing unit during a visit to Automatic Process Control, Inc. Company president and designer of this new unit, August Kraft, explained how it works. Called the on-the-fly-degasser, this apparatus has an advantage over previous equipment in that it will process resin compounds continuously, taking them directly from the shipping drum or storage tank, degassing and dewatering them and delivering degassed compound under pressure directly to the metering and dispersing unit for immediate casting.

This degassing unit, which also operates on the principle of continuously exposing a thin moving film of liquid to an adequate vacuum, consists essentially of an inner cylindrical column and an outer glass column mounted on a metal base. This base holds the variable flow diaphragm inlet valve and the chamber of the air motor driven discharge pump. Electronic controls for regulating flow of the compound through the unit are contained in the control cabinet supported off the base. In the space between the outer and inner cylinders are nickel-chrome ribbon type heating elements which not only reduce the viscosity of the thick compounds to levels for the most satisfactory flow and deaeration, but at the same time aid in the elimination of gases and/or water by vaporization.

In operation, the liquid resin is drawn into the space

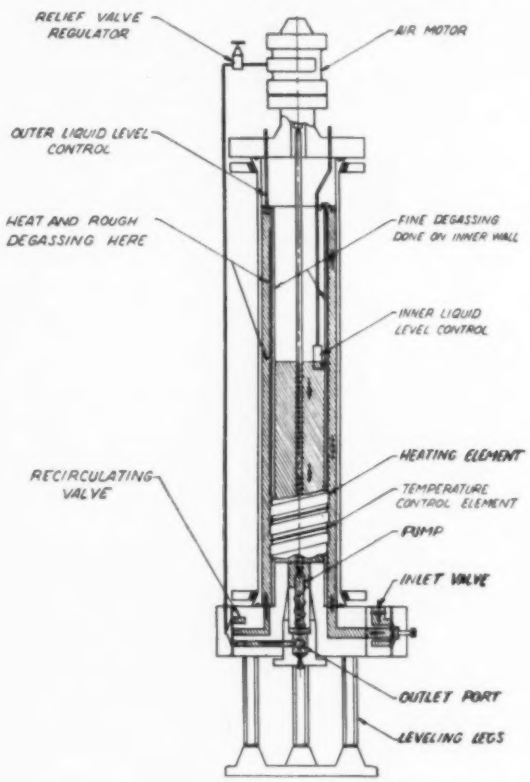



Diagram courtesy: Automatic Process Control, Inc.

Cross section diagram showing operational features of continuous degasser column.

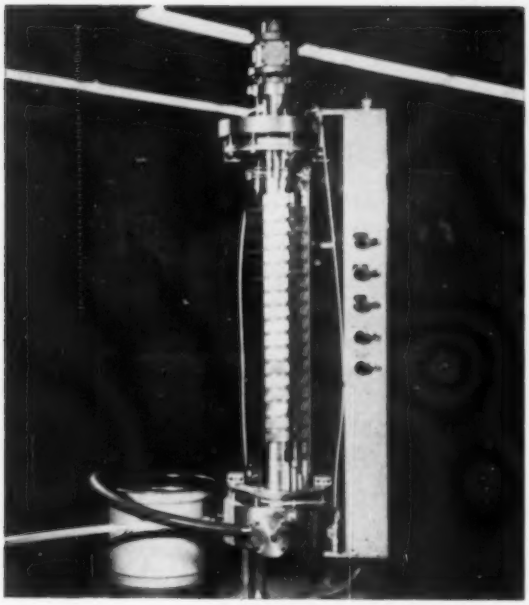


Photo courtesy: Automatic Process Control, Inc.
**On-the-fly degasser unit.**

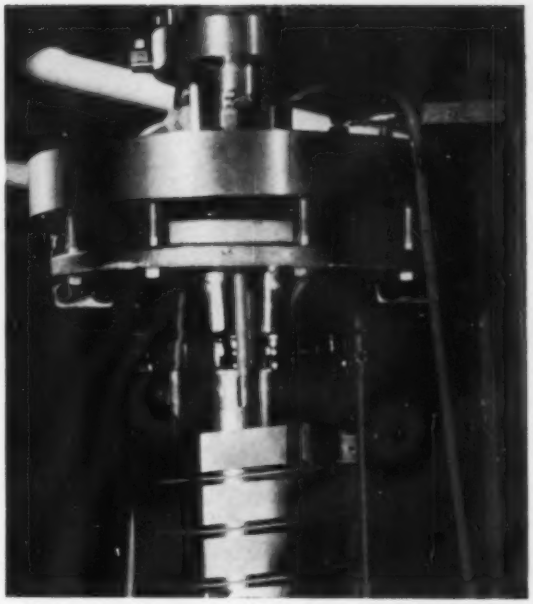


Photo courtesy: Automatic Process Control, Inc.
**Top detail showing outer liquid level probe and air motor location.**

between the outer and inner cylinders by vacuum on demand, is drawn upward over the heating elements where it is thinned out and partially deaerated or dewatered, and then flows over the top on the inner cylinder and down its inner walls where the final degassing or dewatering is accomplished. The level of the liquid in the bottom part of the inner cylinder is maintained constant by a liquid level control probe which in turn controls the operation of the inlet valve. Another liquid level control probe in the space between the outer and inner cylinders and near the top of the inner cylinder maintains a volume of liquid over the heating units or cuts off the current to the heaters when there is no compound flowing through the degasser. Discharge from the degasser by the pump is on a continuous basis; if interrupted for any reason, the unit will recirculate its charge until demand is once more restored.

There are a number of adjustments that must be made in the operation of the degasser in connection with the rate of flow for the most efficient degassing and these depend primarily on the type and viscosity of the compound being processed. These adjustments are arrived at empirically by trial and error and once established can generally be reset for the same type of compound. The unit will handle mixtures of resins as well as single resins, including such types as epoxies, saturated polyesters for polyurethanes, polysulfide casting compounds, and polyvinyl chloride plastisols. It will handle compounds containing most powdered fillers but is not recommended for use with those containing abrasive or fibrous fillers. Neither is it recommended for use with conductive resins or water dispersion or solutions of resins. The capacity of the unit varies depending on the type of compound and the temperature at which it is being run.

In degassing Shell 828 epoxy resin in a trial run, Automatic Process Control achieved a flow of 10 lbs./min. Room temperature viscosity of this resin (16,000 cps.) was thinned to about 1,000 cps. in the unit. The degassed compound could then be fed directly to a mixing and dispensing unit for addition of curing agent, metering and dispensing to the electronic assemblies being encapsulated.

One manufacturer is also using on-the-fly-degassers with a four component resin mix consisting of epoxy resin, coal tar resin, and two curing agents. He found that he could degas either a mixture of the epoxy and coal tar resins or the individual resins separately in the unit, if necessary.

With the use of APC's on-the-fly-degasser, batch operation and storage of degassed compound with accompanying problems of heating, cooling and reheating are reduced or eliminated and processors of casting resins may now operate production lines that are virtually continuous. —THE END

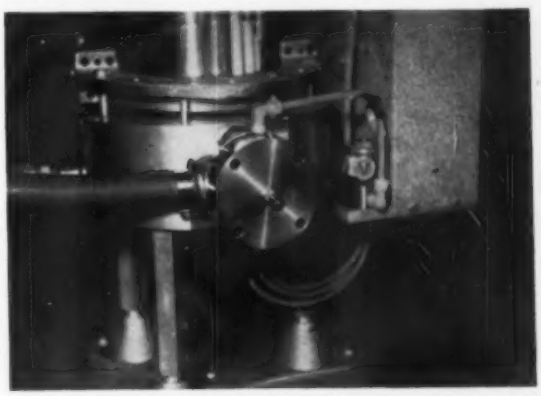


Photo courtesy: Automatic Process Control, Inc.
**Base detail showing diaphragm inlet valve. Interchangeable valves with larger ports are used to feed high viscosity fluids at optimum flow rates.**

HERCULES **Plastics Hi-Lites**

# Pro-fax® proves precisely right

## *A must plastic for many new uses, Pro-fax always provides the most plastic, too*

Because it offers advantages never before available in a thermoplastic, Pro-fax polypropylene has become a "must" for many new uses. But not for exactly the same reasons in every instance. Versatile Pro-fax has many important features unique in its price-property class, and often just a single one of them is ample justification for its usage. Sometimes heat and chemical resistance are the all-important "musts." Again, the economies made possible by the built-in Pro-fax hinge have been foremost in prompting its selection. Its light weight and resilience have on many occasions been prime reasons for specifying Pro-fax.

Whatever the "must," Pro-fax invariably also provides the *most* in a modern construction material. Lightest of all plastics, it yields the most plastic product per pound. Its many innate plus features, in terms of properties, processability and cost, always add up to big value in functionality... merchandising appeal .. and consumer satisfaction.

## Pro-fax is in the picture when heat resistance is a "must"

Resistance to heat from the projector light made Pro-fax a "must" for "Duo-jector." This new magnifier-projector for slides, artwork, photos, coins and stamps has a host of other plus features thanks to Pro-fax: compact, attractively styled, readily portable—since it's made with the lightest of all plastics—Duo-jector is virtually unbreakable, with a rich, colorful finish that is immune to staining and will withstand both use and abuse.

*Molded by Como Plastics, Columbus, Indiana, for Rainbow Crafts, Inc., Cincinnati, Ohio.*

### Pro-fax hinges dispense with assembly costs

Pro-fax was a "must" in this unique dispenser-package for Permacel's RIBBON DOPE* Thread Sealant, a new sealer designed for use on threaded pipe joints. Four integrally molded hinges are combined in a single molded part which opens to accommodate a roll of RIBBON DOPE, then folds and locks together to make a lightweight compact carrier. A snap-in blade cuts tape to any desired length, and the handy unit can be tucked in pocket or tool box, stored in any convenient place, or kept available on the worktable. When product success hinges on functionality plus low cost, Pro-fax provides the *most* plastic for the job.

*Trademark of Permacel

*Molded by Pyro Plastics Corp., Union, N. J., for Permacel, New Brunswick, N. J.*

### DOMINION makes a case for Pro-fax in portable home appliances

All of the advantages of Pro-fax which make it ideal for luggage—light weight, resilience, resistance to scuffing and staining—were needed in the case for Dominion Electric's new hair dryer. But UL listing was required, too. Dominion achieved this by the use of an intumescent coating, applied to the interior surface of this handsome injection-molded carrier. Result: A revolutionary new appliance, a veritable portable beauty salon, easily moved, usable anywhere.

*Molded by Compro Company, Canton, Ohio, for Dominion Electric Corp., Mansfield, Ohio.*

### Many "musts" make Pro-fax the most

The combination of properties available in Pro-fax made this radical new concept in laboratory equipment a reality. Six of these molded "drawers," each holding nine culture tubes, nest in a compact case which permits handling 54 tubes at one time. They replace a cumbersome metal rack which required individual handling of each tube under the microscope and during subsequent cleaning and sterilizing. Pro-fax was a "must" for the resilient retainer rings which anchor test tubes firmly in place so that a full drawer can be studied, washed, and steam-autoclaved without removal. Pro-fax was a "must," too, for the built-in hinge catch on each drawer, designed to hold it in the six-drawer case. All these many "musts" have made Pro-fax the *most* plastic for a variety of new laboratory-ware applications, including test tubes, beakers, and a number of measuring devices.

*Molded by Philadelphia Plastics and Manufacturing Co., Phila., Pa., for Advance Scientific Corp., Phila., Pa.*

**HERCULES POWDER COMPANY**

*Polymers Department*
*Hercules Tower, 910 Market Street, Wilmington 99, Delaware*

GP61-3

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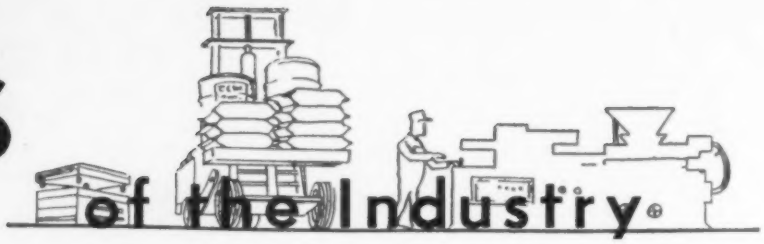
# NEWS of the Industry



**Nopco Chemical Co.,** Newark, N.J., has acquired title to a modern 90,000 square foot building and 18.75 acres of land from the Brown Rubber Co., Lafayette, Ind. Nopco plans to install and operate urethane foam production facilities at this location in the near future. Nopco also exchanged a substantial portion of its stock interest in Brown Rubber, together with notes approximating $350,000, for an undisclosed amount of Mundet Cork Corp.

**Comco Plastics, Inc.,** Richmond Hill, N.Y., a subsidiary of Commercial Plastics & Supply Corp., New York, N.Y., is now extruding rod, tube and shapes of Teflon, as well as fabricating and molding precision parts.

**Hydrocarbon Chemicals, Inc.,** Plastics Div., New York, N.Y., is offering 24-hour package design service for industry called "Instant Packaging," providing overnight delivery of sample high density polyethylene plastic containers complete in every detail for design, color and test marketing evaluation.

**Taylorcraft, Inc.,** Connellsville, Pa., pioneer light aircraft manufacturer, plans the fabrication of fiber glass products by virtue of diversification approved by the new officers and directors of the completely reorganized company.

**Dow Chemical Company's** Torrance, Calif. plant has started the production of polypropylene and is expected to be in operation on a full-scale basis by mid-September.

**Lermer Plastics, Inc.,** Garwood, N.J., will manufacture flexible acetate containers in diameters from ¼ to 1¼ inches in a new division, in addition to its established line of rigid polystyrene and high density polyethylene containers.

**Elm Coated Fabrics Co., Inc.,** New York, N.Y., has announced the availability of unoriented polypropylene film in gages from ¾ mil to 8 mils and in widths up to 54 inches in the following three grades: (1) FDA film without slip additive for overwrap and lamination. (2) FDA film with slip additive for bag stock. (3) Specially formulated film for wire and cable wrap.

**Hydraulic Press Manufacturing Co.,** Mt. Gilead, Ohio, acquired by Koehring Co. in 1956, has changed its name to H-P-M Division, Koehring Co., from the Hydraulic Press Manufacturing Co., a Div. of Koehring Co.

**Industrial Plastic and Equipment Co., Inc.,** Orange, N.J., has changed its name to Industrial Plastic and Engineering Co. to make the corporate name more meaningful and more easily identifiable with the custom molding, fabrication and distribution services of the organization.

**E. I. du Pont de Nemours & Co.** has reduced the price of Teflon FEP fluorocarbon resin by 30%, and introduced two new FEP products.

**Birdsboro Corp.** has formed a chemical machinery division to manufacture a broad range of process equipment. Henry W. North, president of H. W. North Co., will manage the division which will take over the manufacture and sale of the former North-Erie equipment line.

**Charter Industries, Inc.,** is the new name for the former Blavin Industries, Inc., of New Brunswick, N. J.

**Commercial Plastics of Florida's** newly expanded Florida Boat Shield Co. has just opened a new plant in Jacksonville, Fla. Former location was Stark, Fla.

**Henry H. Reichhold** has been appointed to the board of directors of Brookpark, Inc., Cleveland manufacturer of melamine dinnerware and reinforced plastic glazing. This marks the first step in establishing a working relationship between Reichhold Chemicals and Brookpark, it is reported.

**Industrial Plastic & Engineering Co.,** Orange, N. J., has opened a branch plant in Venice, Calif., for custom molding and fabrication of Kel-F and Teflon.

**Koppers Co., Inc.,** has established a panel department within its plastics division to be headed by B. R. Sarchet.

**Kamlar Products Co.** has changed its name to Kamweld Products Co. The firm is located in Norwood, Mass.

**DuPont's** polyethylene plant in Victoria, Tex., is now in full commercial production.

**G-N Equipment Co.** has installed complete custom facilities for the spray application of Metal & Thermit plastisol coatings. An affiliate of Haviland Products Co., G-N is located in Grand Rapids, Mich.

**Etablissements Kuhlmann** of Paris and E. I. du Pont de Nemours & Co. have formed a new company to manufacture and sell isocyanates. The new firm will be called Dekachimie, and will have a plant near Lille.

**Union Carbide Chemicals Co.** has formed an integrated research and development department at its technical center in South Charleston, W. Va.

**Plastics Corp. of America, Inc.,** has acquired Cole Rubber & Plastics, Inc., of Palo Alto, Calif. This is the third plastics operation taken over by PCA since its organization in Dec., 1960.

**Plastic Suppliers** of Blackwood, N. J., distributor-convertor for thermoplastics, has set up converting and warehousing facilities in Dallas.

**Borden Chemical Co.** has opened resin plants in Cali, Columbia, and in Pilar, Argentina. Other programs are underway in France and England.

**Cary Chemicals** has awarded Blaw-Knox a $4-million contract for the design and construction of a 100-million pound per year PVC plant. Scheduled for completion next spring, the unit will be located just west of Burlington, N. J.

**Sterling, Inc.,** has named D. G. Eaton Machinery Co. its representative in Northern Ohio. In addition, it's expanded its representation by Automation Equipment & Supply Co. to include Eastern Ohio.

**Browning Instrument Co.** has announced that its Wohler Foam Tester has been accepted as standard equipment by foam producers and fabricators for testing RMA compression resistance of urethane and vinyl foams.

**Shawinigan Resins Corp.** plans to construct a $½-million executive office and staff building in Springfield, Mass. Completion is expected by mid-1962.

**Walbro Corp.** Cass City, Mich., has purchased Arjay Mfg. Co., Vassar, Mich.

**Chemical Marketing & Research Co.** predicts that 1961 demands for plastic foam should reach 200-million pounds, as opposed to a mere 20-million five years ago. It also predicts that the figure should reach 750-million by 1965.

**Harte & Co.** plans to erect a 44,000 square foot research center in Brooklyn, N. Y., adjacent to its existing film and sheeting plants. Completion is scheduled for 1962.

**Du Pont Co., Ltd.,** is building a multi-million dollar isocyanates plant at Maydown, Northern Ireland.

**Leal Corp.** is offering a complete system for foam-in-place packaging with urethane. This includes design consultation, metering and dispensing equipment, and licenses under patents held by Freeman Chemical Corp. Leal is located in Oaklyn, N. J.

**A. L. Hyde Co.,** Glenloch, N. J., has announced the availability of Delrin 150 acetal resin in strip form. Supplied in coils, the strip ranges in thicknesses from 20-70 mils and in widths of 2, 4, 6, and 8 inches.

**Industrial Plastic & Engineering Co.,** Orange, N. J., has expanded its molding plant by 15,000 square feet.

**Synthane Corp.** has established a sales office in Florissant, Mo. A. J. Rouse will serve as factory representative.

**Mobay Chemical Co.** plans to construct a research center in suburban Pittsburgh—a relocation from New Martinsville, W. Va. Completion is scheduled for the fall of next year.

**E. I. du Pont de Nemours & Co.** and Phillips Petroleum Co. have agreed upon a settlement of litigation over a composition of matter patent for high-density polyethylene. The settlement involves an exchange of patent rights, and Du Pont has moved to dismiss the suit it filed in June, 1958.

**Kordite Co.** has scheduled the construction of a 28,000 square foot warehouse, its second in Macedon, N. Y.

**Cities Service Co.** and Columbian Carbon Co.'s boards of directors have approved a proposed merger, subject to approval by the shareholders and the appropriate regulatory agencies.

**Apex Tire & Rubber Co.** has established a color division for the manufacture and marketing of color concentrates for vinyl processors. Products will include pellets, pastes, and powders.

**Ohmart Corp.** has established a beta gage division which will offer nuclear gages for the measurement of strip and sheet thicknesses. Snowdon Rowe has been named product manager.

**Eastman Chemical Products, Inc.,** has signed Joseph Davis Plastics Co., Kearny, N. J., to a licensing agreement for the extrusion and distribution of Uvex sheet. Uvex is a special outdoor formulation of Tenite butyrate.

**Laramay Products Co.** is distributor in New England for the Seilon plastics line of Seiberling Rubber Co. Seiberling, however, maintains its own sales staff in that area as well.

**KDK Plastics** has announced its third expansion in the last year and a half. Plant and laboratory facilities have been moved to Lewis St., Afton, N. Y., from Harpursville. Correspondence should be directed to Box 348.

**A recommended commercial standard for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications** has been released by the Commodity Standards Division, OTS, U. S. Department of Commerce, Washington 25, D.C.

**Lock Joint Pipe Co.** has opened a $600,000 research and development center at Wharton, N. J. The 23,000 square foot facility houses plastics as well as other separate laboratories.

**Allied Chemical's National Aniline Division** has completed a 20-million pound per year Actol polyether plant at Baton Rouge, La. Allied is the first American company to supply all major components for urethane foams.

**U. S. Plywood Corp.** has added reinforced plastic paneling and accessory items to its building materials line.

**Plastomer Corp.** has expanded production capacity for polyurethane foams by about 25%, and has doubled its die cutting capacity.

**E. I. du Pont de Nemours & Co.** will expand output of titanium dioxide pigment at its New Johnsonville, Tenn., plant by some 30% within the next year.

# Names in the News

Frank M. Chapman

**Frank M. Chapman** has joined Plastic and Rubber Products Co. as general manager of the fluorocarbon division. With Du Pont in the development and application of Teflon since its commercialization, he will now head a division which supplies Teflon industrial parts and components.

**Homer L. Andrews** has been appointed manager of the newly-formed market research department of Molded Fiber Glass Companies, Ashtabula, O., which will be available to customers as well as to the management of MFG's five companies for evaluating molded fiber glass applications. Mr. Andrews was formerly manager of market research for the plumbing, heating and air conditioning group of Crane Co., and for National U.S. Radiator Corp.

**Robert S. Dale** has been appointed eastern representative for **Detroit Mold Engineering Co.**, and will operate from the company's Hillside, N.J. office where he has been located for the past eight years.

Fred W. Leuthesser

**Fred W. Leuthesser** is now vice president in charge of manufacturing and engineering at Tel-A-Sign, Inc., producers of lighted plastic advertising signs. A professional engineer, he has been president of RAD, Inc., general manager of the plumbing fittings section of American Radiator and Standard Sanitary Corp., and an executive with Schaible Co.

Minnesota Mining & Manufacturing Co. has announced the appointment of **Dr. Charles W. Walton** as vice president for research, succeeding **Dr. Carl Barnes,** who recently resigned. Dr. Walton was formerly vice president and general manager of 3M's adhesives, coatings and sealers division. He will be directly responsible for the Central Research Laboratory and the Products Fabrication Laboratory, and for relating activities of staff laboratories with those of division laboratories.

**Thomas H. Manninen** has been appointed technical assistant to the president of Air Reduction Chemical & Carbide Co. Dr. Manninen will review and evaluate plans for new plants, plant expansions, and plant improvements. He was formerly director of chemical and engineering at the central research laboratories of Air Reduction Co., Inc.

**James H. Morrison** has been named sales representative for the western sales district of General Electric's silicone products department, with office location in Downey, Calif. He had previously been connected with the Goodyear Tire & Rubber Co. and Kirkhill Rubber Co.

Norman E. Meese

The three top management position at the new St. Louis blown plastic bottle plant of Owens-Illinois Glass Co. has been announced. **Norman E. Meese** is the plant manager, **Harry R. Wonders** is production supervisor, and **William M. Grable** is administrative supervisor. Messrs. Meese and Grable were located at the company's plant in St. Charles, Ill., and Mr. Wonders at Kansas City.

**George L. Fearnley, Jr.,** has been named manager of Kordite Co.'s new plastics manufacturing facilities in Tyler, Tex. Succeeding him as plant manager in Macedon, N. Y., is **Melvin S. Cagen.** Fearnley, who joined Kordite in 1959, was previously assistant plant manager and production superintendent. Cagen has been successively project manager, manager of semicommercial operations, and plant technical superintendent during the years since 1957. The following promotions have also been announced: in Macedon—**John Kirsch** to production control supervisor, **George Gelinas** to plant controller, and **Albert Lenhardt** to personnel manager; in Tyler—**Dwight Clark** to technical superintendent, **Gordon DeVries** to customer service administrator, **Robert Fenn** to personnel manager, **John Kemmerer** to plant controller, and **James Price** to production superintendent.

**Glenn C. Burnside** has been named general sales manager for Ceilcote Co. As such he will direct all sales activities, as well as coordinate the work of the R. & D. and manufacturing departments.

William D. Sweeny

**William D. Sweeny** has retired as executive vice president of Dobeckmun Co. He joined Dobeckmun in 1932 as general manager, becoming vice president and general manager in 1939 and executive vice president in 1945.

**S. L. Scordelis** is the new manager—services, at the Plastics Technical Center of Shell Chemical Co.'s new Woodbury, N. J., plant. He has been with Shell since 1946, most recently as an engineer at the Emeryville Research Center.

**Hugh G. Johnson,** director of Johnson Rubber Co., retired June 12 from the post he had held for 63 years. He is the founder of the Middlefield, O., company.

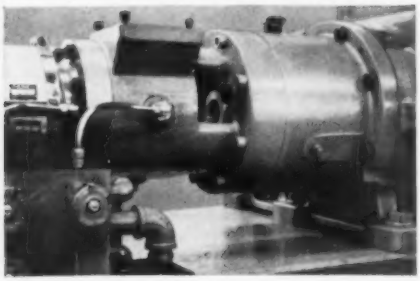
## OBITUARY

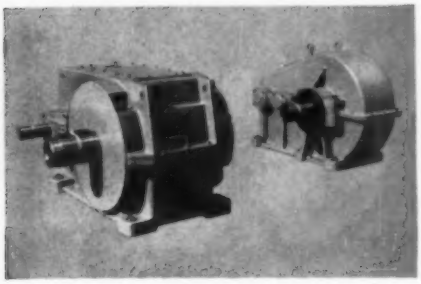
**Armin G. Kessler,** retired vice president and director of Farrel-Birmingham Co., Inc., died suddenly on May 30. Mr. Kessler joined Farrel in 1920 as general manager of the Buffalo, N.Y., plant, and was elected vice president and director in 1923. He retired from the company in 1953, and in 1955 he also retired as director.

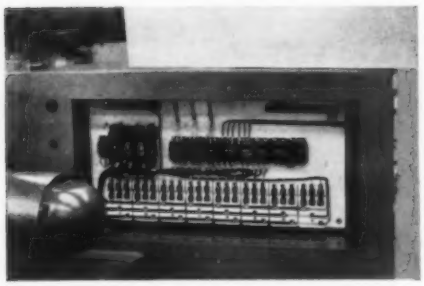
**John Parks Coe,** retired vice president of U. S. Rubber Co. and former general manager of its Naugatuck Chemical division, died at his home on Friday, June 23. Mr. Coe joined U. S. Rubber soon after receiving his B. S. in 1913. He was assigned to several plants, and in 1931 was appointed factory manager of the Naugatuck Chemical division's main plant. He was elected a vice president in 1945.

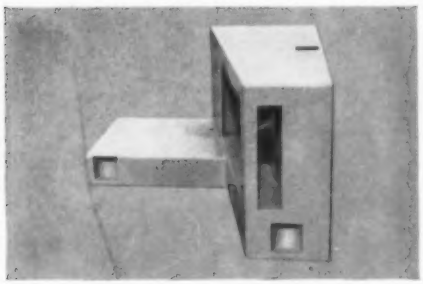
In 1953, Mr. Coe was named to handle the company's interests in the transfer of government-owned synthetic rubber plants to private industry. When U. S. Rubber joined with Texaco in 1954 to form Texas-U.S. Chemical Co., Mr. Coe was elected chairman of the new company. He retired in 1925.

The Commercial Chemical Development Association named Mr. Coe "Man of the Year" in 1952. The following year, Washburn College awarded him an honorary doctor of science degree.



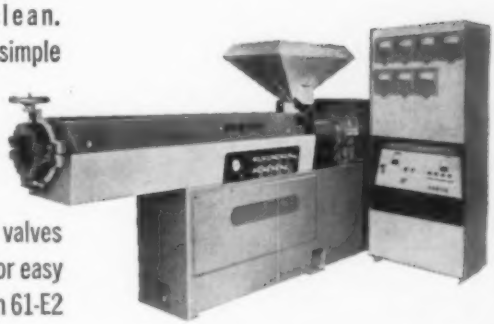






# IT'S ALL NEW

**HEAVIER THRUST HOUSING:** room for single and double row bearings. A larger flange bolted to new gear reducer eliminates the need for additional support under the feed throat. **HEAVIER GEAR BOX,** specially designed and built to Waldron-Hartig requirements. Herringbone gear reducer housing has special large flange. Oil bath lubrication supplies oil generously to gear box and thrust bearings. Machine is **COMPLETELY PREWIRED** to allow for faster, easier installation. Safety disconnect switch is located in extruder base. Heavy wiring from control cabinet to extruder is eliminated. Hartig extruders may be installed and made ready to operate in one day. Covers are well designed, functional; easy to remove, replace, and keep clean. **TRAPEZOIDAL BASE** has simple clean functional lines for strength and easy maintenance. Partition separates blowers from electrical units. Control valves and piping are arranged for easy operation. Ask for Bulletin 61-E2



**. . . AND IT CAN'T BE OUTPERFORMED**

## WALDRON-HARTIG

*technical competence in plastics process machinery*

WALDRON-HARTIG, Box 531, Westfield, N. J./a division of Midland-Ross Corporation MR

For more information check Readers' Service Card No. 116

# New Materials

For more information check Readers' Service Card (p. 77)

## Impact polypropylenes

Four impact grades of Escon polypropylene, combining excellent processibility and low temperature performance, have been introduced by Enjay Chemical Co. Designated Escon 205, 215, 223 and 233, the new resins are intended for use in applications requiring structural rigidity over a wide temperature range.

Escon 205 is a general purpose impact grade combining high flow (melt index, 5.0) and impact strength for most specialty applications. Escon 215 possesses the same properties and processing characteristics of 205, but is formulated using only food-grade additives. Escon 223 is a general purpose, high impact grade formulated for applications requiring exceptional resistance to impact at low temperatures. Escon 233 differs from 223 only in that it contains food-grade additives.

Escon 215 and 233, the two food-grade polypropylenes, are formulated with materials known to be nontoxic and which are either approved for food packaging uses or covered by extensions. These materials have been granted approval by the U. S. Department of Agriculture for use in packaging meat and meat food products bearing marks of Federal meat inspection. Final approval by the Food and Drug Administration is pending.

Some typical properties in connection with impact applications of the four new grades of Escon polypropylene are given below:

| Property | Escon 205- 215* | Escon 223- 233* |
|---|---|---|
| Melt index, gms.110 min., 230 C., 2160 gm. load | 5.0 | 1.0 |
| Deflection temperature | | |
| °F. @ 264 psi fiber stress | 121 | 112 |
| °F. @ 66 psi fiber stress | 179 | 143 |
| Impact strength, ft. lb./in.: Izod unnotched | | |
| −40° F. | 8 | 17 |
| 0° F. | 9 | 25 |
| 72° F. | 50 | No break |

*From injection molded samples.

*Readers' Service Item 1*

## Crosslinking polyethylenes

Two vulcanizable polyethylene wire extrusion compounds, Bakelite HFDA-4201, in natural and colors, and Bakelite HFDA-4203, in black, have been introduced by the Union Carbide Plastics Co. They are said to offer improved physical and thermal properties unmatched by available thermoplastics for insulation and jacketing. The compounds are chemically crosslinked by passing the insulated wire or cable through a continuous vulcanizer after extrusion.

HFDA-4201 is for use as primary insulation in high voltage cable where it will permit operation at considerably higher temperatures than other insulating materials. HFDA-4203 provides an optimum balance of physical properties and flexibility for line wire and service drop insulation.

It is expected that operating temperatures as high as 90°C.(194°F.) will be possible with these vulcanized polyethylenes, and stress-cracking is eliminated. Meanwhile, the excellent abrasion and impact strength, tensile, chemical resistance, aging and weathering over a wide temperature range of conventional polyethylene are retained. Some of the properties of these Bakelite vulcanizable polyethylenes are given in the table below:

| Property | HFDA-4201 | HFDA-4203 |
|---|---|---|
| Specific Gravity | 0.93 colors 0.92 nat. | 1.176 black |
| Tensile strength, psi. | 2200 | 2400 |
| Elongation, % | 450 | 200 |
| Secant modulus, psi. | 18,000 | 28,000 |
| Brittleness, 20% fail., °C. | −90 | −70 |
| Deformation, %, 500 gms. @ 120° C. | 15 | 10 |
| Stress cracking, hrs. | >500* | >500* |
| Dielectric constant, 1 mc. | 2.35 col. 2.28 nat. | 6 |
| Dielectric strength, v./mil. | 500 | 275* |
| Dissipation factor | .0005 col. .0003 nat. | 0.022 |
| Volume resistivity | $>1 \times 10^{13}$ | $>1 \times 10$ |

*Time of test termination.

*Readers' Service Item 2*

## Nylon-base reinforced plastic

Tayloron PN, a nylon fabric impregnated with phenolic resin reinforced plastic which features light weight and low thermal conductivity, has been introduced by the Advanced Materials Division of Taylor Fibre Co. The new material was specifically developed for rocket applications and may be used for components which exceed 4000°F. for short periods of time. Tayloron PN has excellent physical, thermal, and erosion characteristics; good dielectric strength; is highly machinable; and exhibits high deflection under load.

Some typical property values are as follows:

| | |
|---|---|
| Specific gravity | 1.2 |
| Ultimate flexural strength, psi. | |
| Lengthwise | 13,000 |
| Crosswise | 12,500 |
| Thermal conductivity, 200° F. | 0.71 Btu. in./ft.²/hr./°F. |
| Specific heat | 0.47 Btu./lb./°F. |
| Diffusivity, 250°F. | 1.37 ft.²/hr. |
| Coefficient of expansion (Range −30° C. to +30° C.) | |
| Lengthwise | $7.35 \times 10^{-6}$ in./in./°C. |
| Crosswise | $6.44 \times 10^{-6}$ in./in./°C. |

Tayloron PN is supplied in every form required for high temperature applications. These include: Sheets 49 x 49 in. from 1/16 to 1/4 of an in. thick; molded rod from 1/4 of an in. minimum diameter; plate up to 9 in. thick; molded tube from 1/4 in. minimum I. D. and 1/16 in. minimum wall thickness; rolled tube from 3/8 in. minimum I. D. and 1/8 in. minimum wall thickness; molded shapes in built up forms; and molding forms (B stage or prepreg) in sheets, rolls, and cut squares.

*Readers' Service Item 3*

## Self-crosslinking resin latex

X-Link 2833, a self-crosslinking vinyl-acrylic copolymer resin latex that is said to offer unique formulating and end-property advantages as a binder, has been developed by the Resin Division of National Starch and Chemical Corp. The new latex forms strong and flexible films with exceptional resistance to water, solvents, and creep. Its use eliminates problems of stability, odor, compatibility, and the high curing temperatures usually associated with combinations of thermosetting and thermoplastic resins.

As a binder for non-woven fabrics it provides strength and softness with excellent heat and light stability, resiliency, good tear and tensile strength, washfastness, and dry-cleanability. In wallpaper coverings the use of X-Link 2833 as a pigment binder has resulted in color coats with high resistance to staining, alcohol, and water. The latex also imparts flexibility and high tensile and tear strength, to cellulosic and synthetic fiber papers in saturating operations.

Other suggested applications are as a tie coat for organosols and alone or in combination with such finishing agents as softeners or wash-and-wear resins for durable fabric finishes.

*Readers' Service Item 4*

## Glass fiber gun roving

A new glass fiber gun roving product, "7170", with a specially formulated chrome-type binder has been developed by Johns-Manville. The new roving is soft, static-free, features fast wet-out, and is designed to work efficiently with all types of spray-up guns. J-M's gun roving chops cleanly without clumping, and readily conforms to intricate shapes and radii when laid down. The new product's softness factor, which traps resin without draining, results in an absence of dry areas in all laminates having ratios of up to 40% glass content.

Typical spray gun applicators pull continuous strands of roving from the inside of the package into a glass fiber chopping device mounted with the spray nozzles. As the chopped strands spray out of the cutter they are co-mingled with predetermined amounts of catalyzed and promoted resin drawn from nearby containers. After the surface of the mold or form is covered to the desired thickness, a short roll-out operation is required for each application

## use Pfizer CITROFLEX® A-4 . . . accepted by the F.D.A.

Here's food for thought. Now, you can choose a food-package plasticizer that is safe, non-toxic, odorless—and economical. Pfizer CITROFLEX A-4 has been accepted by the F.D.A. for use in packaging for *both fatty and non-fatty foods.* It shows excellent results in plasticizing vinyl films, coatings and plastisols . . . also in polyvinyl acetate adhesives. Look to Pfizer first for a complete line of non-toxic plasticizers. Send for Technical Bulletin #31 on Citroflex Plasticizers. Write to Chas. Pfizer & Co., Inc., Chemical Sales Division, Plastic & Plasticizer Dept., New York 17, N. Y.

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■ FOR OTHER-THAN-FOOD APPLICATIONS, INVESTIGATE THE PFIZER LINE OF STANDARD AND CUSTOM-TAILORED MORFLEX® PLASTICIZERS, WHICH INCLUDES: Morflex® ADIPATES, Morflex® AZELATES, Morflex® POLYESTERS, Morflex® SEBACATES.

For more information check Readers' Service Card No. 117

AVISUN POLYPROPYLENE GIVES "FORM-FIT" COMFORT TO ALLADIN PLASTIC CHAIRS

# First Injection Molded

For this major advance in furniture making, Alladin Plastics, Gardena, Cal., uses AviSun polypropylene. Here's why: • *Amazing strength*—In Alladin's thumping, rocking torture test, AviSun Impact Grade Polypropylene outlasted all materials tested—endured up to 375 times longer. • *Supple comfort*—like that of upholstered furniture. • *Chemical and stain resistance*—to detergents, alcohols, oils, foods and cleaners—unharmed by sun and weather. • *Mold cycles*—as fast as 60 seconds with no post-mold aging. • Get the facts on how polypropylene can upgrade *your* product from: AviSun Corporation, 1345 Chestnut Street, Philadelphia 7, Pa. • In Canada: Courtaulds Plastics Canada, Limited.

AVISUN*

*Trademark of AviSun Corp.

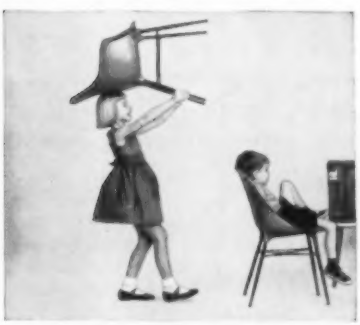
For more information check Readers' Service Card No. 118

# Why AVISUN polypropylene was chosen

Toughness and resiliency of polypropylene give the Alladin chair the ability to shrug off all kinds of rough handling.

Polypropylene's tensile strength, inherent in the material and easily designed into the chair, was highest by actual test over all competitive materials.

# Chair



Because polypropylene is lightest of the plastics, the chair can be carried about with ease by any member of the family.

until completion of the spray-up, ready for curing. The static-free quality of the new roving means all strands lay down flat on the mold and roll out easier and quicker.

Advantages of the sprayed-up glass fiber system include less expense in materials than hand lay-up or low quantity matched metal die molding, easy conformance to large complex shapes, quicker delivery potential, design change freedom, suitability to prototypes, small production and protective coatings, and low cost equipment that is portable.

*Readers' Service Item 5*

## Flexible gel coatings

CoRezyn Flexible Gel Cotes, based on a new basic polyester resin and capable of good gloss, hiding power, and excellent flexibility for use with glass fiber reinforced plastics, moldings and laminates, are available from Commercial Resins Corp. The coatings have good scuff and mar-resistance, excellent weather resistance, and will withstand 24 hours in boiling water.

CoRezyn Gel Cotes have been formulated to be ready for immediate spray gun use after addition of MEK peroxide catalysts. The coatings appear heavy in the container but will easily flow through a pressure pot spray gun. With 1% MEK peroxide the pot life is about 30 minutes at room temperature, with 2% MEK peroxide the pot life is about 15 minutes. The Gel Cote should be cured about 30 minutes after application, although additional time may sometimes be required.

A translucent Gel Cote, which can be colored by the addition of 2-5% by weight of polyester color pastes, and a white, flexible Gel Cote are available from stock. A large assortment of already colored Gel Cotes are also available from stock.

*Readers' Service Item 6*

## Epoxy impregnating compounds

Isochemfil 211 and 216 systems are high temperature epoxy impregnating compounds for either the vacuum or a combination of vacuum and pressure impregnation of electronic components available from Isochem Resins Co. They are used with Catalyst 215X, a new accelerator replacing tertiary amines for curing methyl nadic or other anhydride resins systems, and which extends pot life, maintains low viscosity, shortens cure time, and provides for satisfactory operation of the finished products at high temperatures.

Isochemfil 211 is an unfilled, low viscosity, 100% epoxy impregnating resins system for use where high heat stability (500°F.) coupled with excellent physical and chemical properties are required. It has excellent adhesion to metals, wood, concrete, etc., and a pot life of 2-4 weeks. Isochemfil 216 is a lower viscosity undiluted systems, contains no reactive diluents, and furnishes top electrical properties. Both are light amber resins and can be supplied filled or colored according to user requirements. A small amount of Isochem Diluent #1 can be added to the 211 system to further reduce viscosity, if necessary. Isochemfils 211 and 216 are also available in 211 thixo- and 216 thixo- to prevent drip in cure.

Some typical properties of the liquid Isochemfils and the cured resins are as follows:

| Liquid Isochemfil | 211 | 216 |
|---|---|---|
| Brookfield viscosity, 25° C., cps. | 3000 | 600 |
| Specific gravity, 25° C./25° C. | 1.18 | 1.15 |
| Storage life | Indefinite | Indefinite |
| Viscosity with activator, cps. | 1000 | 400 |
| **Cured resin** | | |
| Specific gravity, 25° C. | 1.2 | 1.2 |
| Heat distortion temp., °C. | 165 | 180 |
| Ult. tensile strength, psi. | 11,600 | 13,000 |
| Hardness, Shore D | 89 | 89 |
| Flexural strength, psi. | 20,500 | 12,000 |
| Compresive strength, psi. | 19,000 | 17,000 |
| Water absorption, % | 0.30 | 0.20 |
| Dielectric constant, $10^3$ cycles | 3.7 | 4.0 |
| Volume resistivity, ohm-cm. | | |
| 72° F. | $1 \times 10^{16}$ | $1 \times 10^{16}$ |
| 400° F. | $5 \times 10^{12}$ | $6 \times 10^{14}$ |
| Power factor, $10^3$ cycles | 0.02 | 0.02 |
| Dielectric strength, v./mil. | 480 | 490 |

*Readers' Service Item 7*

## Epoxy curing agents

Pentamid 1 and Pentamid 2, liquid polyamide resins for use as curing agents for epoxy resins, have been announced by the Heyden Chemical Div., Heyden Newport Chemical Corp. They are condensation products of polymerized fatty acids and suitable polyamino compounds.

In use, these curing agents are blended with epoxy resins employed primarily in coating, tooling, and adhesive applications. When cured, such blends possess flexibility; exceptional adhesion; high mechanical strengths; excellent resistance to solvents, chemicals and water; and ease of handling.

Some typical properties of Pentamids 1 and 2 are given below:

| | Pentamid 1 | Pentamid 2 |
|---|---|---|
| Color, Gardner | 10 max. | 12 max. |
| Amine value | 200–225 | 290–320 |
| Viscosity, poises, 75° C. | 30–50 | 8–13 |
| Ash, % | 50 ppm | 50 ppm |
| Spec. gravity, 25° C./25° C. | 0.99 | 0.97 |
| Pounds/gal., 25°C. | 8.2 | 8.1 |
| Flash point, °C. | 234 | 198 |

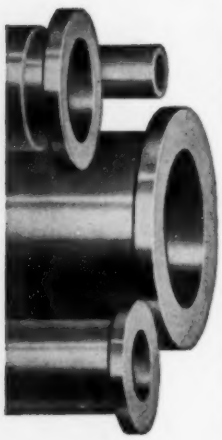
*Readers' Service Item 8*

## Tenite sheet for outdoor use

Uvex plastic sheet extruded from special formulations of Tenite butyrate for outdoor use is available from the Plastic Sheeting Div., Eastman Chemical Products, Inc., and by sheeting extruders under license from Eastman including Jet Plastics and General Plastics Corp. Supplied

# only Xaloy

## meets every requirement in extruder cylinders



**1**... **because** Xaloy *bimetallic cylinders* are available in *all* sizes, engineered to meet the individual requirements of plastics and rubber processors.

**2**... **because** the mirror-smooth surface of Xaloy liners allows maximum production, hour after hour, in continuous service.

**3**... **because** Xaloy cylinders have proven to be the most advanced liners for extrusion machines over the past 25 years.

**WRITE FOR NEW XALOY DATA GUIDE**

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# IMS DEHUMIDIFYING OVEN

## CUT DRYING TIME on ALL THERMOPLASTICS

***The Only Oven Designed to Dry Nylon to Minimum Moisture Content***

**Fan speed control. 10KW for fast heat recovery. Totally enclosed heating elements. ½ HP fan motor. Mechanical air-drier five times more efficient than desiccant. Requires NO operator attention.**

Tray size: 15″ wide x 30″ long x 2″ deep
Floor space: 5′ 3″ x 30″ deep x 5′ 4″high
**Shipped from Stock.....$1885.86**

(220 volt, 60 cycle, 3 phase)

**ORDER NOW**

**INJECTION MOLDERS SUPPLY CO. INC.**
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**CADET**

# ORGANIC PEROXIDES

**BENZOYL PEROXIDE**
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For more information check Readers' Service Card No. 121

in thicknesses from 0.060 to 0.125 of an inch, the sheet is said to have low moisture absorption, high surface gloss, and excellent dimensional stability. It is currently available in clear, white, and five popular light-stable sign colors: red, blue, green, yellow, and black. The clear sheet has the ability to transmit up to 90% of visible light.

Uvex sheet requires no pretreatment and can be deep drawn in either vacuum, air pressure, or mechanical processes, permitting excellent forming detail even on intricate mold contours, according to Eastman. The sheet can be effectively and economically decorated and painted with lacquers, paints, or inks applied by any of the conventional methods, including silk screening and distortion printing.

*Readers' Service Item 9*

## Oriented acrylic sheeting

Tuffak, a colorless, molecularly-oriented acrylic sheet in two sizes, 42 by 42 and 84 by 84 inches, and in a thickness of 0.050 of an inch only, is available from Rohm & Haas Co. The new material is said to combine the excellent outdoor weathering properties of the company's Plexiglas acrylic sheet with better craze resistance under stress or in presence of solvents, a notable increase in tensile elongation before rupturing, and a remarkable reduction in notch sensitivity. It can be nailed or punched without cracking if proper techniques are used. Stamping at 90° F. with punch and die sets equipped with stripper plates is recommended as a production technique. Tuffak is extremely flexible and can be readily cold formed.

As a glazing material, Tuffak provides a practical solution for a wide range of problems, and ease of installation is another important advantage. It offers a tough, rigid, transparent material, exceptionally light in weight, and highly weather resistant. It may be installed by conventional calking methods or the sheet may be riveted or nailed to a frame. Electrical properties are good.

*Readers' Service Item 10*

**Also worth mentioning—**

☐ Zytel 53 nylon resin, a transparent material which Weather-O-Meter tests show to have twice the weatherability of other natural colored resins, has been added to E. I. du Pont de Nemours & Co.'s line of plastics. It is said to have excellent stability and flexibility, and is suggested for hookup wire, control cable, building wire, automotive ignition wire, etc., where transparency and resistance to occasional sunlight are requirements. Black Zytel 53X is recommended for continuous exposure to sunlight.

*Readers' Service Item 11*


# How SANTICIZER® 409 gives vinyl products high-priced properties at the lowest cost of any premium polymeric plasticizer

**PERFORMANCE:** SANTICIZER 409 *stays put.* Its compatibility-stability is superior, under highly humid conditions, particularly when formulated with heat-stabilizing epoxy plasticizers. SANTICIZER 409 stubbornly resists migration to polystyrene—and to both natural and synthetic rubbers—as well as extraction by solvents. Stability to light and heat is exceptional. There's hardly a trace of odor or color.

**PROCESSING:** The good solvating action of SANTICIZER 409 can boost your output, too. Promotes fast fusion and extrusion. Helps prevent "fisheyes," roughness, and pinholes.

**PRICE:** SANTICIZER 409—*at 4¢ to 6¢ per lb. LESS than other premium-quality polymerics*—imparts top-quality performance to many kinds of vinyl products.

**PROOF:** Try it . . . "on paper," in the laboratory, in the plant. Compare SANTICIZER 409 with *any* other polymeric plasticizer (price, properties, stability, ease of processing). You will see that SANTICIZER 409 gives *more profit per unit volume of vinyl compound.*

**FACTS:** Technical Bulletin PL-409 gives complete performance data—including specific details on how SANTICIZER 409 can help you make:

- **105° wire compound with exceptional electrical properties and retention of elongation.**
- **permanent, adhesive-backed film.**
- **migration-resistant, low-odor refrigerator gasketing.**

Monsanto

*Monsanto Plasticizer Council . . . for plasticizer guidance that pays!*

**MONSANTO CHEMICAL COMPANY**
**Organic Chemicals Division**
**Plasticizer Council, Dept. 4410-A**
**St. Louis 66, Missouri**

*Please rush my copy of Technical Bulletin PL-409.*

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For more information check Readers' Service Card No. 122

# New Equipment

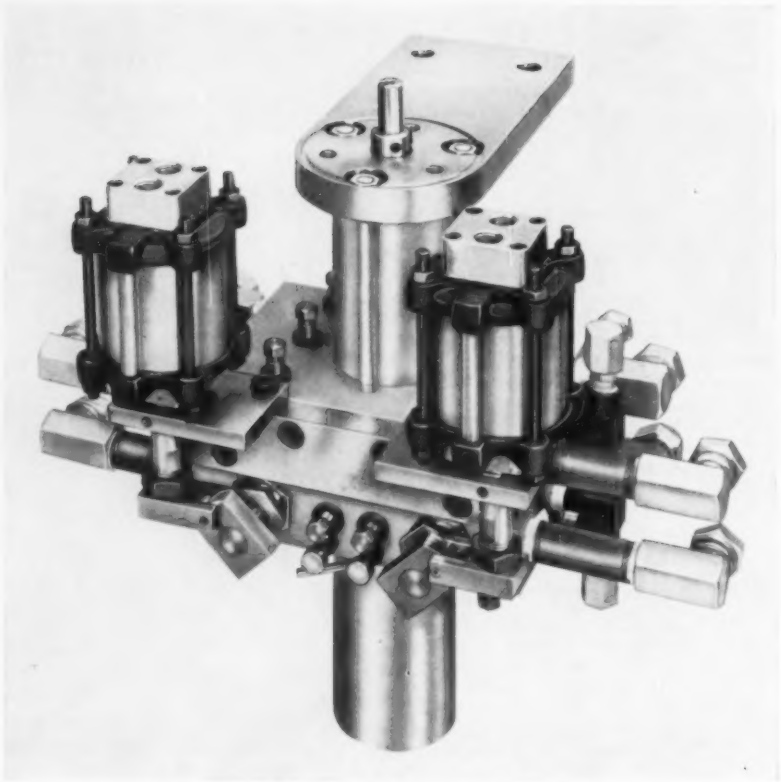
## Large urethane foam mixing heads

Large model mixing heads for two, three and six component polyurethane foam systems, with mixing chamber, impeller, metering ports, and overall construction larger than the standard model mixing head, have been announced by Martin Sweets Co., Inc. These large model mixing heads are nominally rated at 100 lbs./min. and make possible the pouring of large foam masses on shot-type, production installations.

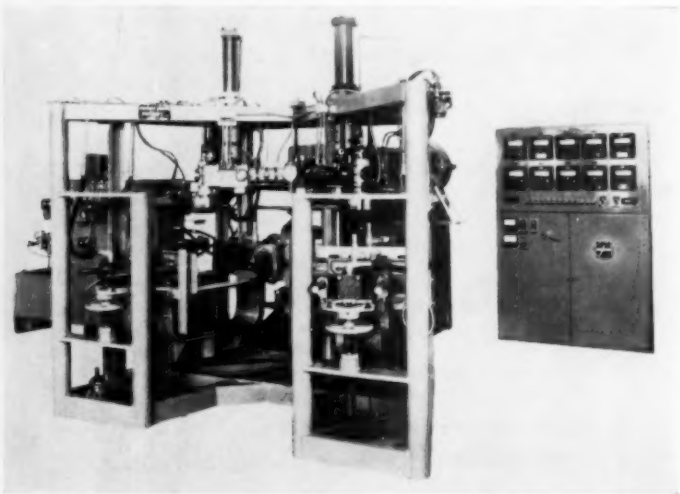
A three-way valve developed by Martin Sweets is utilized in the six-component design twice, each valving three of the six total streams of foam constituents with individual air cylinders. Sixteen needle valves are incorporated into the six-component system for adjusting stream pressures and controlling product quality. Two additional openings into the mixing chamber are furnished for air injection and solvent flush. The multiple-component design eliminates the pot life time factor previously encountered when premixing of some ingredients resulted in material loss through chemical deterioration.

Many formulations can be mixed at rates in excess of 150 lbs./min. for molding, pouring-in-place, or slab production of rigid and flexible foams, it is said.

*Readers' Service Item 21*



Six-component, large model urethane mixing head.



MPM's new V-21 OHP blow molding machine; control console at right.

## Blow molding machine features accumulator for fast extrusion

The V-21 OHP Diversamatic blow molding machine of Modern Plastic Machinery Corp. is equipped with piston-type accumulators which act as material reservoirs and provide the high pressure needed for fast parison extrusion. Each Xaloy-306-lined accumulator has a 16,000-pound plunger force and reservoir capacity ranging from 30 to 150 cu. in. Parts can be made ranging from 1½-inch diameter to 13½-inch diameter and from 2-inch to 35-inch length, depending on the accumulator size.

Mounted between the extruding head and the die at each of the machine's two blow molding stations, the accumulators make possible a continuous flow of material, since one fills during the cooling cycle while the other is forcing out the parison into the space between the open die. This twin-station feature of the V-21 OHP model enables it to use either identical or different right and left side molds at the same time. Molds may be single cavity or vertically-strung multiple cavity design.

The new blow molding unit is designed for blowing the parison at the top, bottom or through the side of the mold. The machine is equipped with photo-electric safety devices and has an automatic, air-powered takeoff device to eject the finished product. The entire operation is electronically regulated from a preset control console located near the molding equipment.

*Readers' Service Item 22*

For more information check Readers' Service Card (p. 77)

## Automated preform preheating

Thermex equipment that makes possible completely automated dielectric preheating of plastic preforms to molding temperatures is available from the Girdler Process Equipment Div., Chemetron Corp. Integrated with Thermex plastics preheaters, the new all-electric device indexes and loads preforms, controls high frequency preheat cycles, and delivers the heated material direct to transfer pots of molding presses in automatic repeating sequence. Complete cycles are as short as 18 seconds for typical loads.

Preforms move from a hopper bin via a vibrating feeder and loading chute to the infeed ramp of the heating unit. After one load is heated and delivered to the press, metal fingers select alternate preforms from the waiting line and load them on the sliding tray of the preheater unit for another cycle. The alternate spacing (which leaves open air around each preform) and vertical positioning, (which lessens expansion problems during the heating cycle), ensure more uniform heating. Preforms can be handled in any rectangular size or shape up to about 3 x 4 by 1¼ inches thick. Six preforms are handled in ordinary operation and up to twelve without alternate space loading.

The unit can be supplied complete with vibrating feeder and delivery mechanism, or can be integrated with existing feed and press installations. It can be adapted to deliver heated preforms to an operator area for manual transfer to individual cavities or compression molds. Alternate methods for automatic delivery of stacks of heated preforms to vertical transfer presses are offered also.

Automated handling and preheating unit for plastic preforms. Vibrating feeder (left) keeps loading chute to infeed ramp filled. Unit indexes and loads preforms on edge into preheater, controls preheat cycles, and delivers heated pellets (on ramp at right) direct to molding press.

*Readers' Service Item 23*

## Ceramic infra-red heaters

Elstein ceramic infra-red trough elements, electrically-heated sources of infra-red radiation said to have the advantages of low cost, simplified installation, and high heating efficiency in a wide variety of industrial applications, are available in the United States from Roundout Market-


# How MOD-EPOX® liquefies viscous epoxy resins and "liquidates" some of the cost

**PERFORMANCE:** Reactive MOD-EPOX reduces epoxy resin viscosity as much as 75%, combines *chemically* in the curing to become part of the resin. This means you can use more filler, yet have faster flow, less entrapped air, fewer rejected finished parts. And final properties are actually *improved:*

**FLEXURAL STRENGTH OF 4-PLY GLASS FIBER-EPOXY LAMINATES (ASTM D638)**

| FORMULATION: | Control | with MOD-EPOX |
|---|---|---|
| MOD-EPOX | — | 25 |
| liquid epoxy resin | 100 | 100 |
| diethylenetriamine | 12 | 8 |
| magnesium oxide (fluffy) | — | 0.25 |
| **FLEXURAL STRENGTH:** | **psi** | **psi** |
| original | 42,400 | 48,400 |
| ketone—40 hrs. @ room temp. | 42,400 | 47,700 |
| water—40 hrs. @ 100°C. | 29,400 | 37,600 |
| 10% caustic—27 hrs. @ 100°C. | 8,500 | 9,200 |

Epoxy resins modified with MOD-EPOX for better flow and lower cost show better dimensional stability—lower power factor—equivalent hardness—and higher adhesive strength (*shear bond strength of a standard epoxy adhesive increases more than 50%, steel-to-steel*).

**ECONOMY:** NOW . . . MOD-EPOX at 36¢/lb.* costs less than any grade or brand of epoxy resin, 50-75% less than most other modifiers . . . AND reduces the curing-agent requirements to about ⅔ of usual amounts.

**FACTS:** Technical Bulletin PL-313 gives complete performance data—including specific details on how MOD-EPOX can help you make:

- **easy-handling electronic potting compounds.**
- **low-cost auto-body-solder formulations.**
- **high-strength casting and encapsulating compounds.**
- **tenacious adhesives for metals and glass.**

*T/L and C/L, F. O. B. Monsanto, Illinois

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**Organic Chemicals Division**
**Plasticizer Council, Dept. 4411-A**
**St. Louis 66, Missouri**

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For more information check Readers' Service Card No. 123

ing Associates, Inc., in 150, 250, 400, 650, and 1000 watt sizes. Widely used in European plants for more than 10 years, the heaters have an average life of more than 10,000 operating hours.

The high quality element wire, made of special alloy, is baked into the ceramic material, just under the white, glazed, flake-proof surface, where it is protected against chemical corrosion and oxidation. Emission efficiency of 96% of capacity is claimed. The design of the trough provides an extensive radiation surface which produces a uniform and diffuse radiation field, even at close distances.

Large radiation areas, radiation tunnels, and ovens of all types can be built up to any size by mounting the units side by side. A spring quick-clip permits easy installation of individual heaters, which are designated as FSR and FSR-G.

*Readers' Service Item 24*

## Cutter slits 18 foam sheets

A new horizontal multi-cut machine that can slit a block of synthetic foam into as many as 18 sheets simultaneously has been developed by Falls Engineering and Machine Co.

A block of trimmed or untrimmed foam is placed on the power driven conveyor belt of the machine and fed into the cutting mechanism of one to 18 horizontal hot wires. The cutting wires can be set at angles for cutting wedges. The machine

FEMCO's horizontal multi-cut machine.

will handle foam blocks up to 69 inches wide by 37 inches high and up to 20 feet long, if idler rollers are used at the end of the conveyor.

Cuts made by hot wire are clean and accurate and there is no "flip-up" at the end of the cut since the stock is not under compression. The machine is pre-set and requires no adjustment between cuts. Scrap loss is greatly reduced and the several sheets of foam are immediately ready for packaging without any rehandling of the fabricated sheets.

FEMCO is also producing a vertical multi-cut machine which will make 18 vertical cuts in two directions simultaneously.

*Readers' Service Item 25*

## Portable mixer and grinder

Gabb Special Products, Inc. has introduced Model RL Shear-Flow portable mixer for dispersing, blending and homogenizing plastic materials. Available with motors from 2 to 10 hp. all parts subject to immersion are made of stainless steel and corrosion resistant materials.

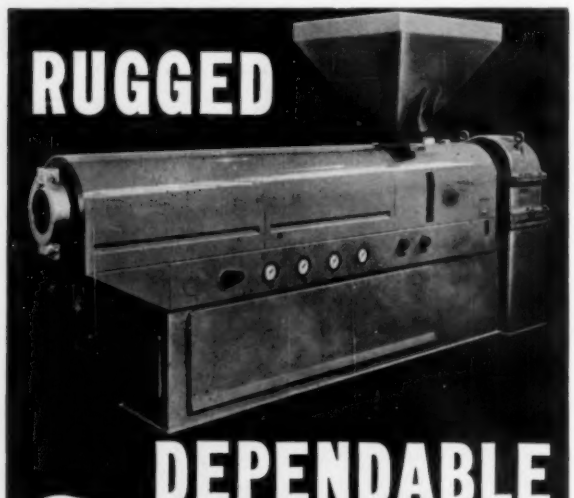
The mixing head consists of two rotating impellers and two stationary stators enclosed within a cylindrical housing. The clearance between the impellers and stators is such that a more complete reduction of agglomerates within a mixture is obtained.

The mixer has been used successfully in the mixing of polyester resins with activators, dissolving granulated resins, epoxy resins and hardeners, and mixing polyethylene. It has been used also in the grinding and mixing of plastics and synthetic rubber with thinners.

*Readers' Service Item 26*

## Reactive resin processing unit

The Multi-Rez processor, a complete production unit for proportioning, dispensing and mixing multi-component reactive resins such as epoxies and polyurethanes, is available from CPM Special Machinery Corp. Proportional accuracy of the two-component media dispensed is maintained through mechanical linkage operating positive displacement pumps and called the proportion-variator. This new device permits changes in ratio settings with a simple adjustment of an arm around a calibrated dial and broadens the ratio range allowing settings of 1:1 and 100:1. In addition, the Multi-Rez processor will dispense an adjustable predetermined volume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of the two components in proportion.

Thorough blending of the resin mix is accomplished by a motorized mixer with a Teflon impeller. Short pot-life resin mixes can be handled with ease and safety.

*Readers' Service Item 27*

## Machine prints 3,600 flat surfaces per hour

Model 70AB automatic machine for printing flat surfaces of plastic or metal boxes, covers, pans, and similar items is available from Markem Machine Co. The machine will make one-color imprints as large as 2 by 3 inches at a speed of approximately 3,600 pieces per hour.

Designed to be incorporated in an in-line production system, the machine uses either a manually-fed chute or automatic feeding. In both cases, ejection is automatic. Quick-changing type, which allows variable information to be printed without significant loss of production time, is used and inventories of preprinted boxes are thus eliminated.

Markem 70AB is a production model machine.

*Readers' Service Item 28*

**Also worth mentioning**

☐ The Trim-O-Matic hydraulic press cuts out multiple parts in one complete, automatic operation and also cleanly trims skin-packaged parts, cutting away all excess material. Cutting cycle is preset according to thickness of material being trimmed; and two start buttons, one on each side, require the use of both hands. Platen area is 18 by 18 inches; ram force is 16 tons. The 45-inch high, 27½-inch wide, 43-inch deep press by Product Packaging Engineering may be rolled to any place in the plant and plugged into any 115 volt outlet.

*Readers' Service Item 29*

☐ A kit of stainless steel lining tips for its welding torches is available from Laramy Products Co. Consisting of one basic lining tip and five attachments, the kit includes a flat ⅝ of an inch tip, a "V" tip, an auto seal tip ⅝ and ¾ of an inch wide strip, a second auto seal tip one inch wide strip, and a Penton tip both flat and corner. The tip attachments are easily removed and attached by a single screw.

*Readers' Service Item 30*

☐ A small size, beta gage for applications in industrial research laboratories and pilot plant operation, has been developed by Ohmart Corp. Only 22 inches long, the new measuring instrument will accurately indicate or record the thicknesses of sheet materials up to 12 inches wide. It is available in three models.

*Readers' Service Item 31*


# How SANTICIZER® 160 speeds processing and cuts costs of nonstaining PVC film and sheeting

**PERFORMANCE:** No other plasticizer can make film, sheeting, and floor covering so *STAIN-SAFE*—virtually impervious to asphalt, tar, grease, mustard, catsup, coffee, and other stainmakers. SANTICIZER 160 (butyl benzyl phthalate) also imparts toughness, high gloss, *and outstanding tear strength and dimensional stability.*

**PROCESSING:** Quick-fusing SANTICIZER 160 speeds Banbury mixing, milling, and calendering—*at lower processing temperatures.*

**ECONOMY:** SANTICIZER 160 is one of the lowest-priced primary plasticizers for vinyls. With its high tolerance for fillers and its high compatibility—*150 PHR for poly(vinyl chloride), 75 PHR for poly(vinyl acetate)*—it offers compounders savings on material, savings on formulation.

**"TAILORED" BLENDS:** In large-volume applications, when several plasticizers are used together in a fixed ratio for optimum performance, Monsanto can usually *custom blend* them to your specifications . . . to reduce your storage-facility requirements; eliminate mixing error or variation; and reduce inventory requirements, ordering costs, and production expense.

**FACTS:** Technical Bulletin PL-160 gives complete performance data—including specific details on how SANTICIZER 160 *also* can help you make:

- **lower-cure-temperature plastisols and organosols.**
- **high-gloss, water-resistant lacquers.**
- **economical vinyl chloride-vinyl acetate emulsions.**

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**Organic Chemicals Division**
**Plasticizer Council, Dept. 4412-A**
**St. Louis 66, Missouri**

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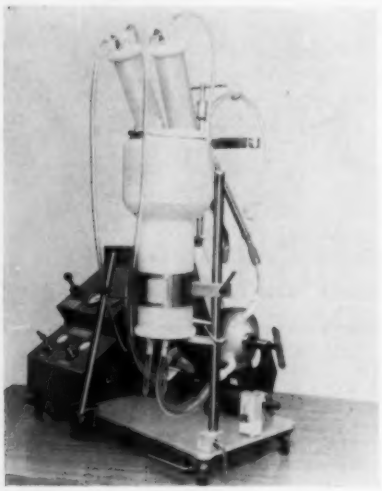
For more information check Readers' Service Card No. 126

# Plastic Applications

## Polypropylene blood pump

The Pulspirator, a pump oxygenating apparatus which enables blood to bypass the heart and lungs during open heart surgery, is manufactured by Foregger Co. from Avisun Corp. polypropylene. Recently cited for excellence in design engineering, six different fabrication methods —blow molding, vacuum forming, extrusion, mechanical forming, and inert gas welding—are required before assembly of blood handling components of this apparatus is complete. A light weight, compact, portable unit which requires little blood priming, the apparatus represents a marked advance in connection with this vital surgical procedure, it is said.

After exhaustive materials testing, polypropylene proved to be the only one able to meet requirements for the Pulspirator, which specified that the material be: physiologically inert; able to withstand repeated autoclaving at 260°F. and retain size and shape; translucent; light weight; strong and impact resistant; able to be joined with mating edges perfectly sealed and permanently bonded with no addition of toxic substances; and able to be extruded and formed.



Pulspirator blood pump.

*Readers' Service Item 41*

Earth Path Indicator for astronauts.

## Device for astronauts has acrylic globe

Minneapolis-Honeywell Regulator Company's space engineers have developed a unique device for Project Mercury called the Earth Path Indicator. Designed to help the astronaut return safely to earth, the device permits him to see where he is over the earth at all times as he orbits at 17,000 or more miles an hour.

The Earth Path Indicator consists of a transparent globe made of Rohm & Haas Plexiglas acrylic plastic by Farquhar Transparent Globes, inside a box with complex gearing systems. Markings on the globe show longitude, latitude, continents, topography and major cities. The globe revolves in two directions simultaneously, on a north-south axis like the earth and on a second-turn axis to simulate the travel of the Mercury capsule around the revolving earth.

The astronaut, after he reaches orbit, will set the Earth Path Indicator using information relayed to him from ground tracking stations. From then on the globe will act as an analogue computer, always pinpointing two locations, where the astronaut is and where he would land if he pushed the re-entry button.

*Readers' Service Item 42*

For more information check Readers' Service Card (p. 77)

Hot sun causes some vinyls to give off volatiles that "fog" windows. Bar-O-Sil stabilizer inhibits this condition.

# Tests show Bar-O-Sil* stabilizer inhibits troublesome "fogging" of car windows due to vinyls

**Bar-O-Sil supplementary stabilizer also checks spewing, crocking, plating and blocking in processing of vinyl film, sheeting and extrusions.**

Car manufacturers noted that heat causes some vinyl upholsteries to give off volatiles that "fog" windows. Tests show that Bar-O-Sil, complex barium silicate supplementary stabilizer, inhibits this condition in vinyls. In addition to alleviating this problem, Bar-O-Sil promotes the following desired characteristics in vinyl film, sheeting and extrusions.

### Promotes colorant performance and "dry hand" qualities

Bar-O-Sil has a high adsorptive capacity that provides improved control of migration of color and plastic ingredients to the surface. Bar-O-Sil also has low reactivity with sensitive colorants. These important properties contribute to more effective control of bleeding, spewing and crocking during processing – promote desired color and "dry hand" qualities in vinyl film, sheeting and extrusions.

### Speeds production runs by reducing plate-out

In all stabilizing systems containing barium, cadmium or zinc compounds, Bar-O-Sil reduces plate-out on rollers during calendering. In this way, Bar-O-Sil saves time by permitting quick color changeovers, and speeds production runs.

### Other helpful benefits

Bar-O-Sil's high adsorptive capacity controls blocking of vinyls in storage and in use. The presence of Bar-O-Sil is important, especially when post-laminating or post-embossing operations are to be conducted as a separate step, some time after the initial processing stage.

### Send coupon for more information

For detailed information covering the many useful properties imparted to vinyls by Bar-O-Sil supplementary stabilizer, fill out the coupon below.

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**BAR-O-SIL*** *(Stabilizer)*

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111 Broadway, New York 6, N.Y.

For more information check Readers' Service Card No. 127

## Non-woven fabrics

Fiberloc, a mechanically bonded fabric for a variety of applications, is available from Felters Co. The fabric can be made with any man-made fibers, bonded by a technique that eliminates the felting process.

Because permeability is controlled during manufacture, Fiberloc is ideal for filtration. Tensile strengths up to 1,500 can be obtained. The material will not fray or ravel when die cut. By using special fibers, the material can be made highly acid-, alkali-, and heat-resistant. It is manufactured in widths to 108 inches, and thicknesses to 1 inch.

*Readers' Service Item 43*

## Insulated, disposable plate

An insulated and disposable plastic plate for outdoor and everyday informal use, priced to be competitive with paper, has been introduced by Guild Plastics, Inc., a division of Maryland Cup Corp. The plate, which can be used to serve hot and wet foods, is formed of laminated sheet stock consisting of Lustrex high impact polystyrene fused to Santofome flexible styrene foam film, both products of Monsanto Chemical Company's plastics division. The outer cushion of insulating foamed plastic gives body to the plate and helps keep it in place.

*Readers' Service Item 44*

## Acetal screws

Gries Reproducer Corp. is molding screws from Du Pont's Delrin acetal resin. The line parallels the types and sizes of GRC molded nylon screws.

The screws are available in six head types: round, binding, oval, washer, flat, and fillister; and six point types in headless set screws: plain, oval, cone, flat, half dog, and full dog. Threads range from 0.80 to ¼-20.

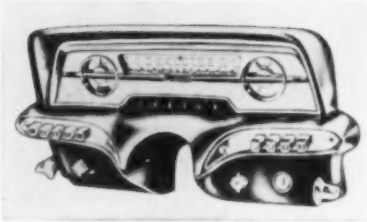
*Readers' Service Item 45*

## Glass reinforced polyester tank for corrosive service

The availability as a stock item of a horizontal, cylindrical, 1,000-gallon processing tank fabricated from a glass-reinforced specialty polyester resin (Atlac 382 of Atlas Powder Co.) has been announced by Justin Enterprises, Inc. The filament wound tank is recommended for industries where corrosive conditions necessitate a structure with high chemical resistance. Its translucent allows easy observation of the liquid level. Other capacities, ranging from 50 to 10,000 gallons, are also available.

Complete with manhole, stainless steel fittings, and mounting saddles, the tank is 10 ft. long, 30 inches in diameter, has a wall thickness of ¼ of an inch, and weighs 300 lbs., as compared to 2,000 lbs. for a comparable stainless steel unit.

*Readers' Service Item 46*



Dodge Lancer ABS instrument cluster.

## ABS instrument panel

A focal point in the interior design of the 1961 Dodge Lancer is the instrument panel cluster molded of the tough, heat-resistant Cycotac ABS, a product of Marbon Chemical div., Borg-Warner Corp., by Kent Plastics.

Pounds lighter than metal, the molded plastic cluster has proved far superior in cost, appearance and durability over the previously used diecast metal unit. Easily metallized, the Marbon material offers dimensional stability, hardness and resistance to wear, and the plastic unit requires little post-installation finishing. This ABS plastic instrument panel provides Lancer owners with a cluster that will not rust, stain or tarnish and remains new looking for the life of the car.

*Readers' Service Item 47*

## Vinyl-coated Fiberglas louvers

Vinyl-coated Fiberglas vertical louver blinds, 7,900 yards of them, have been installed in the main passenger terminal at Lambert Field, the municipal airport at St. Louis, Mo. The louvers are of varying lengths to conform to the semi-circular shape of the vast window areas in the airport terminal, the longest being 30 feet in length. Because the plastic-coated Fiberglas blinds are dimensionally stable, they will not stretch or shrink.

The blinds were manufactured by the Hessler Vertical Blind Co. The Fiberglas yarn of Owens-Corning Fiberglas Corp. was woven by Hess-Goldsmith & Co., Inc., a member of Burlington Industries. E. I. du Pont de Nemours & Co., Inc. fabricated the shade cloth, called Tontine Triglas, utilizing heavy DuPont vinyl and glass fabric. The DuPont shade cloth reportedly has about three times the breaking strength of conventional cotton-based shade cloth, substantially higher tearing strength, and unusually high resistance to aging and discoloration.

*Readers' Service Item 48*

## Largest Teflon molding

Raybestos-Manhattan, Inc., Plastic Products Div., has molded what it believes is the largest Teflon billet ever produced for any purpose. The giant tube, developed for prototype work on a classified missile project, has an inside diameter of five inches, an outside diameter of 12 inches, and is 24 inches long. The billet is part of a three piece set with a total weight of about 340 pounds and includes also two

***You're looking at the world's finest molding press . . . the 90-ton BIPEL Fully Automatic Compression Press . . . the ultimate in production and economy!***

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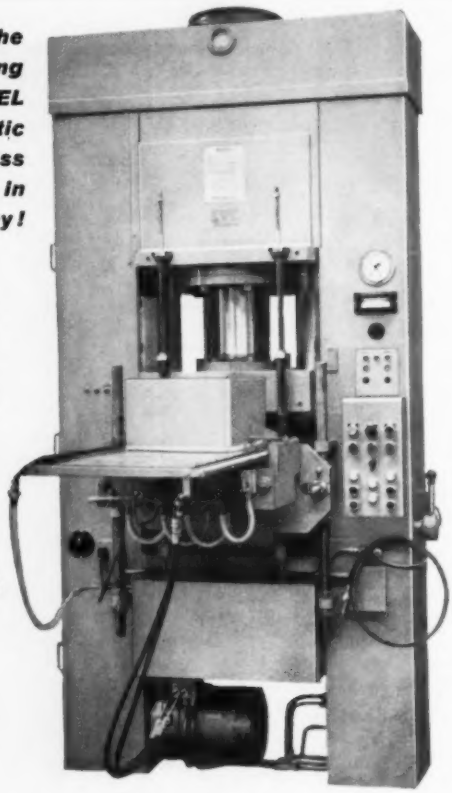


For more information check Readers' Service Card No. 128

# LOOK----------

# it's all one piece!

**Opening and closing this one-piece carrying case demonstrates the remarkable "hinge" property of TENITE POLYPROPYLENE**

Flexed a million times in one continuous laboratory test, a molded specimen of Tenite Polypropylene—the Eastman plastic with the "built-in hinge"—showed never a crack. That's why this case can have its base, cover, and handle molded as a unit, with obvious savings in design, fabrication, and assembly.

Made for a child's typewriter, the case is well able to take slam-bang treatment that will come its way. The high abrasion resistance demonstrated in this use gives long life to the beauty of many products made from Tenite Polypropylene, and also suggests its use for gears, bearings, and similar hard-working parts.

In addition to being injection molded, Tenite Polypropylene can be extruded into film, sheeting, and monofilaments, and in special formulations is adaptable to blow molding, where its exceptional strength permits thin walls. The film is sparkling clear, heat-sealable, printable, and an effective moisture barrier—important features in packaging. Rigid sheet is readily thermoformed on standard equipment into large-scale sections or skin packaging.

As extruded wire covering, Tenite Polypropylene exhibits excellent electrical and thermal properties. And formulations combining weatherability, low-temperature flexibility, and high tensile strength may be used to produce monofilaments that are ideal for such applications as webbing for outdoor furniture.

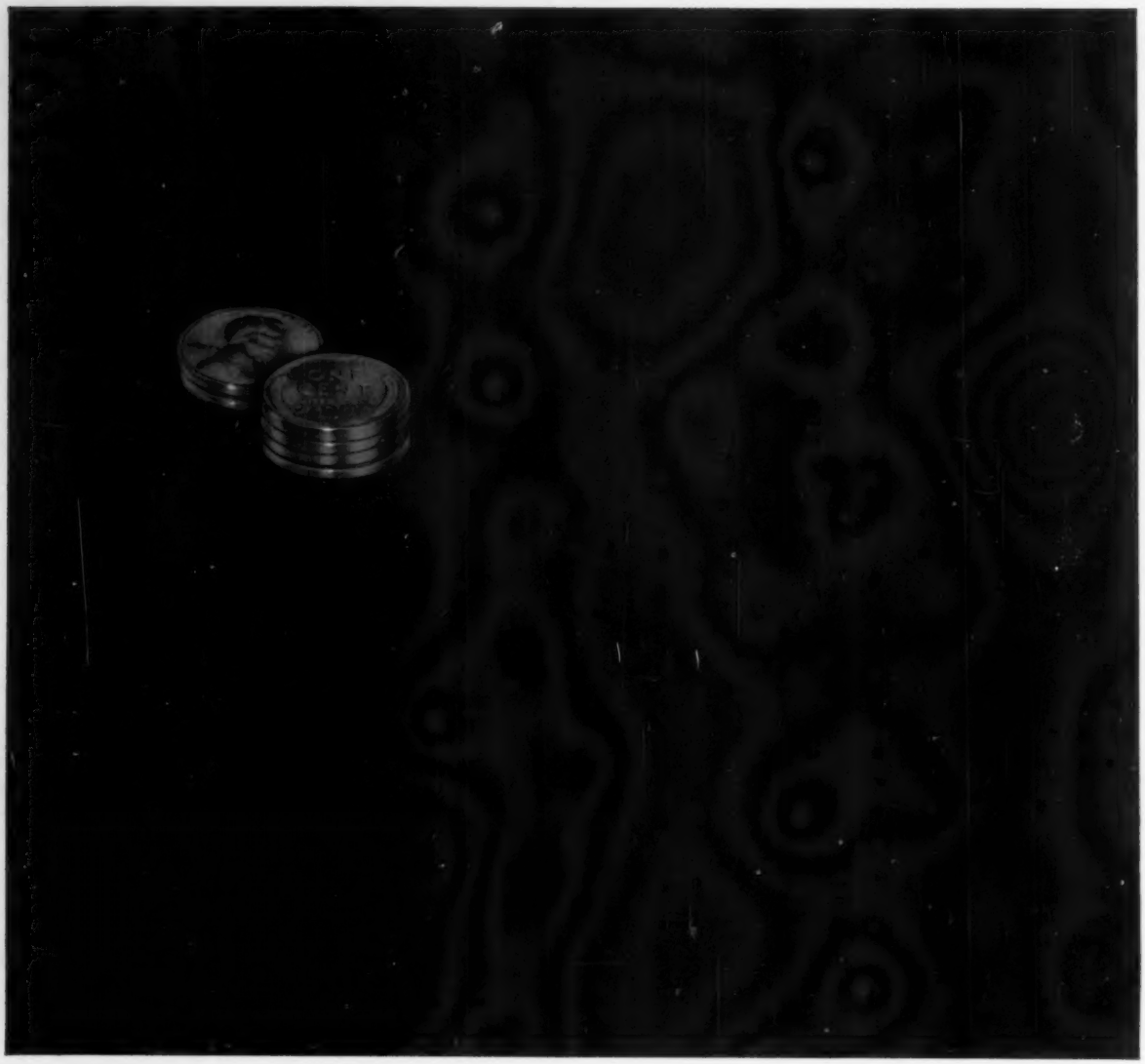
With the lightest weight of any solid plastic, Tenite Polypropylene gives the greatest product yield per pound. As for colors, thousands of vibrant hues are available in Tenite Polypropylene—or in color concentrates for mixing with uncolored plastic to produce the desired color when molded or extruded. Eastman experience in coloring plastics extends over 25 years, with additional background in color photography and textile dyes. In applying this plastic to your product ideas, you can call on the aid of Eastman's technical representatives and its extensive laboratory facilities. For information on Tenite Polypropylene or any other plastics in the Tenite family—butyrate, acetate, propionate, or polyethylene—write EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

*Carrying case molded by manufacturer of the "Tom Thumb" typewriter, Western Stamping Company, Jackson, Michigan.*

# TENITE®

## POLYPROPYLENE

*an Eastman plastic*



# the few extra pennies that buy next year's vinyl business

We believe that these few pennies, invested in the right plasticizer, buy next year's vinyl business . . . the repeat business that stems from confidence in the consistent quality and performance of your product.

Why? Because these few additional pennies buy a proven low-temperature winner . . . Plastolein 9058 DOZ. We'll admit that cheaper low-temperature plasticizers appear tempting. But do they warrant putting the future of your business in jeopardy?

With time-tested Plastolein DOZ you are sure of lasting low-temperature flexibility . . . excellent heat and light stability . . . low volatility . . . unusually good "hand" . . . all the qualities that lead customers to buy (and buy again) with confidence. Isn't this your strongest appeal for next year's vinyl business . . . your best assurance of continued profit?

If you are not familiar with Plastolein 9058 DOZ, send for evaluation samples or full information today. Write Dept. Q-9.

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large Teflon molded rods, all of which were produced in duplicate and subsequently machined to final dimensions. Special processing was necessary during manufacture to prevent stresses and then each unit was X-rayed to be certain there were no internal voids or fractures.

*Readers' Service Item 49*

## Powder molded PE tank

A new thick-walled, extra-large polyethylene container which provides dependable, economical storage for as much as a ton of liquid or bulk product is being introduced for use in meat packing and processing plants by the Sintrex division of Amos Thompson Corp.

The new polyethylene tank, ideal for transporting, storing, or handling unprocessed meats, is molded from Microthene, U. S. Industrial Chemicals Co.'s powdered polyethylene, by a new powder molding process. By this process, Sintrex is able to produce large parts which would be difficult or impossible to make by injection or blow molding.

The container combines strength and light weight with resistance to meat and food juices, chemicals, acids, and alkali solutions, and is virtually unaffected by temperature variations. It has smooth, seam-free surfaces for easy sanitation.

Large PE industrial tank.

*Readers' Service Item 50*

**Also worth mentioning—**

☐ Sun Rubber Company's Go-Places toys of squeezable vinyl include a jet plane, motor boat, sports car and fire engine. They have no moving parts. These hollow toys represent an approach to supplying the small child with toys that move. They all have two-way, two-tone squeaker voices.

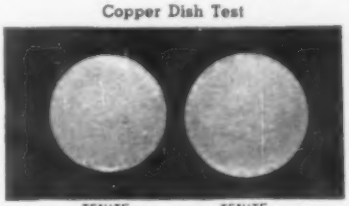
*Readers' Service Item 51*


# TENITE DEVELOPMENT LABORATORY DOINGS AND FINDINGS

### Less Than 0.01% Ash

It has been found that some polypropylene—not all, just some—is subject to oxidation and resulting degradation in applications involving contact with copper or copper alloys. (Coated copper wire and ballpoint pens with ink cartridges made of a copper alloy are typical examples.) A simple and easy-to-make test identifies the culprit in the line-up. Just melt some polypropylene pellets in a copper dish and let it cool to room temperature. If oxidation occurs, the plastic develops a brown discoloration. Perform this test on appropriate Tenite Polypropylene formulations and you'll find you get practically no discoloration. Here's the clean result:

**Copper Dish Test**



TENITE POLYPROPYLENE 4232 CONTROL

TENITE POLYPROPYLENE 4232 1 HR. AT 185°C.

The chief reason Tenite Polypropylene resists oxidation so effectively is that it is manufactured by a unique Eastman process that leaves consistently less than 0.01% ash in the product. This low ash content also means a low electrical dissipation factor. And for molded products, low-ash Tenite Polypropylene lets color stand out rich and bright.

*Of course, we add very small amounts of appropriate materials to improve certain properties — but without additives, Tenite Polypropylene is 99.99% pure. It floats, too, in case you're interested.*

### Vacuum Forming Polypropylene

Here is a helpful hint for vacuum forming polypropylene plastic sheet. Screen both upper and lower heaters with 8-gauge stainless steel mesh. This will help distribute the heat evenly and eliminate "hot spots" which sometimes cause sheet to rupture when vacuum is applied. A sheet 100 mils thick reaches forming temperature in about 30 seconds when held between two mesh-covered heaters at 1075°F. For a tough and durable vacuum-formed product, use sheet extruded from a high-impact formulation of Tenite Polypropylene.

### Unsolicited Testimonial

Recently, on a lonely park lane, a company installed an experimental street light globe fabricated of Tenite Butyrate plastic. The lane, as it turned out, was a popular rendezvous for young lovers. One morning the globe was found badly battered.

Evidence indicated that someone had tried to put out the light with a stone. Failing in this, the person climbed the pole, threw the globe to the ground, and smashed the light. The globe, however, was still unbroken, so the vandal put it against the curb and ran over it with his car. He was apparently impressed by the strength of the plastic material because he wrote a little note which he stuck in the battered globe before putting it back on the pole. The somewhat colorful language in the note prevents our quoting it directly, but the gist of it was that to break one of these new plastic globes was just too much trouble.

The resistance of Tenite Butyrate to shock is so great that even when globes are pierced by BB shot and small bullets, they remain in a serviceable condition. For this reason, New York City's orange-colored light globes are now being made of Tenite Butyrate. These are the globes that are mounted atop a pole to indicate the location of fire-alarm boxes.

*Special outdoor formulations of Tenite Butyrate combine weather resistance, rigidity, and excellent light-transmission and diffusion properties with an Izod Impact Strength as high as 2.0 ft. lb./in. of notch in an MH flow. This combination is unexcelled among thermoplastics for serviceability in such uses as street-light globes, outdoor signs, and lenses for automobile taillights, railway signals, and traffic-control lights, to name but a few. For more information about Tenite Butyrate for outdoor applications, contact your nearest Tenite representative or* EASTMAN CHEMICAL PRODUCTS, INC., *Plastics Division,* KINGSPORT, TENNESSEE.

TENITE®

*plastics by Eastman*

For more information check Readers' Service Card No. 131

# New Literature

For more information check Readers' Service Card (p. 77)

**"Sonite LM-23 and SC-4."** Technical Bulletins 22E and 22F. Smooth-On Mfg. Co. 4 pages. The bulletins concern a system for fabricating laminated tools which retain strength in continuous operation at 350° F. One is an epoxy laminating resin; the other a surface coat epoxy used in combination with the laminating material.

*Readers' Service Item 61*

**"Cadco Teflon."** Cat. TFE-359. Cadillac Plastic & Chemical Co. 8 pages. Stock sizes of sheets, rods, tubing, tapes, cementable etched tapes, and large diameter molded bars and cylinders. Properties and end uses of Teflon shapes are described.

*Readers' Service Item 62*

**"Dylan and Super Dylan Polyethylenes."** Koppers Co., Inc. 8 pages. Characteristics and features of a line of polyethylenes. Includes a complete range of densities.

*Readers' Service Item 63*

**"Square Foot Converter."** Commercial Plastics & Supply Corp. 12 pages. Conversions for plastic sheets up to 67 by 102 inches. Booklet provides decimal equivalents; and sheet, rod, and tube diameters and thicknesses.

*Readers' Service Item 64*

**"Abrasion Tester."** U. S. Testing Co. 2 pages. Features, applications, and operation of a tester to determine wear or abrasion resistance of textiles, plastics, and protective coatings.

*Readers' Service Item 65*

**"The Isochem Resins Line."** Isochem Resins Co. 2 pages. Brief listing of standard resins. Includes epoxies for dipping, coating, and potting; silicones; vinyls; and related materials.

*Readers' Service Item 66*

**"Oxiron Epoxy Resins."** Technical Bulletin 2. Food Machinery and Chemical Corp. 6 pages. This bulletin supplies data on high temperature properties of epoxies and on their potential in laminate applications. Describes different cure systems—formulation and cure cycle—for these resins.

*Readers' Service Item 68*

**"Automatic Reset Dial Timer."** Bulletin N-305B. Automatic Timing & Controls, Inc. 8 pages. Includes data on construction, installation, application, functions, circuit arrangements, and electrical data. Controllers are used for time control of industrial processes, laboratory, and machine automation.

*Readers' Service Item 69*

**"Tenite Acetate Formula 081."** Materials Bulletin No. 7. Eastman Chemical Products, Inc. 2 pages. Typical extrusion conditions and properties of Tenite Acetate 081, a new formulation developed especially for extrusion into clear sheet that will not blush, cloud or haze when subjected to deep-draw vacuum forming, are given in this bulletin.

*Readers' Service Item 70*

**"New LTV-602 Clear Silicone Potting Compound."** Bulletin CDS-280A. General Electric Co., Silicone products dept. 4 pages. LTV-602, the first in a series of low temperature vulcanizing compounds designed to provide mechanical and dielectric protection for electronic components and assemblies, is described. Available in liquid form, it cures at 70° to 80°C. to a flexible, resilient solid.

*Readers' Service Item 71*

**"Prevent Rust with Rust-Lick 606."** Brochure No. 611. Rust-Lick, Inc. 4 pages. Features, applications and packaging of Rust-Lick 606, a specially formulated, spray-on, moisture-absorbing, lubricating-type rust preventive are described. The film is non-drying and is easily removed by wiping, alkaline washing or solvent degreasing.

*Readers' Service Item 72*

**"Tenite Polyethylene Compounds for Pipe Extrusion."** Materials Bulletin No. 8. Eastman Chemical Products, Inc. 2 pages. Properties and extrusion data on Tenite Polyethylene 2521E-60099 Black for Type II polyethylene pipe, and Tenite Polyethylenes 2721E-80060 Black and 2811E-80010 Black for Type III polyethylene pipe, as defined by Commercial Standard CS197-60, are given.

*Readers' Service Item 73*

**"Copper Clad Micarta."** B8215. Westinghouse Electric Corp., Micarta division. 8 pages. Seven grades of laminates for printed circuits can be compared in physical and electrical properties. Recommended applications are included for each laminate to guide selection.

*Readers' Service Item 74*

**"White Mineral Oil for Use in the Plastic Industry."** Sonneborn Chemical & Refining Corp. 9 pages. Review of applications in which mineral oils and fully refined hydrocarbon distillates are used in the manufacture of various plastics. Typical physical properties of pertinent white oils and distillates are tabulated.

*Readers' Service Item 75*

**"Durapipe Molded Plastic Pipe Fittings."** Durapipe & Fittings Ltd. 4 pages. Photographs, sizes, and types of ABS and PVC fittings. Directions for jointing are also supplied.

*Readers' Service Item 76*

**"Tempak Mineral Oxide Insulated Thermocouple Materials."** Catalog 2550. Temptron Instrumentation Equipment. 10 pages. Describes process to produce thermocouple material. Provides specifications and descriptive data on the metal-sheathed, ceramic-insulated wire.

*Readers' Service Item 77*

**"Syl-Off Silicone Coatings."** No. 8-605. Dow Corning Corp. 6 pages. Describes silicone coatings for release purposes, and shows how they save time and money. Includes samples of Syl-off coated paper.

*Readers' Service Item 78*

**"Design Considerations for Applying Reinforced Plastics in the Corrosive Environments of the Process Industries."** Atlas Chemical Industries, Inc. 8 pages. Presents a table for estimating the degradation of tensile strength in RP laminates under 14 practical service and production conditions, and illustrates its use in the mechanical design of three components.

*Readers' Service Item 79*

**"Transparent Plastic Tubing."** Cobon Plastics Corp. 12 pages. Catalog and price list of transparent tubing and fittings. Chemical resistance tables are included.

*Readers' Service Item 80*

**"Machining Laminated Plastics."** Synthane Corp. 8 pages. Presents descriptions of 11 machining operations, recommendations on tools and practices, and hints for designing with laminated plastics. Illustrations show the right and wrong way.

*Readers' Service Item 81*

**"Temperature Regulator Catalog."** TCV-1. OPW-Jordan. 8 pages. Contains illustrations, engineering information, and technical data on temperature regulators. Self or pilot-operated models available from ¼ through 6 inch sizes.

*Readers' Service Item 82*

Product and package both made of MARLEX. SPORTYAK* boat packed in TR-101 blown-tubing bag (pigmented red) made by Canton Containers, Inc., Canton, Ohio.

# King-size bag of MARLEX* TR-101 film reduces packaging, handling, and shipping costs for popular new SPORTYAK

Dayton Bait and Marine Products Company of Dayton, Ohio, is marketing the remarkable seven-foot SPORTYAK (completely made of MARLEX high density plastic) in an equally remarkable plastic shipping bag eight feet long and 40 inches in diameter. Made of film blown from MARLEX TR-101 tailored resin, this giant bag is only seven mils thick . . . yet provides shipping and handling protection comparable to the heavier, bulkier cardboard cartons previously used.

Mr. J. M. Buening, Executive Vice President at Dayton Bait and Marine, says, "These TR-101 bags save us money . . . are better for our purposes than cardboard boxes. Packing is faster and requires less effort. Packaged boats are lighter and easier to handle . . . cost less to ship. Of course, with these boats, our main concern is protection from abrasion, marking, scarring, and the like. Thin as they are, MARLEX bags do the job . . . giving us factory-to-customer protection for the SPORTYAK. This film made of MARLEX TR-101 is amazingly tough."

In addition to outstanding toughness, bags made from MARLEX TR-101 high density resin can withstand extremes of temperature (from hot storage at 140°F to cold storage below zero F)... resist moisture, rot, bacteria, fungi, acids, alkalies and most chemicals. It also has been proven that thinner-walled TR-101 bags outperform thicker-walled low density polyethylene bags . . . having up to 38% more tensile strength and 2½ times the impact strength.

For marketers and packagers currently using paper, jute or low density polyethylene bags, cardboard boxes, metal or fiber drums . . . new TR-101 film can mean more efficient, less costly packaging.

For technical and processing data on TR-101 resin... market applications for TR-101 film—contact your nearest MARLEX office listed below.

*MARLEX is a trademark for Phillips family of olefin polymers. †SPORTYAK is a trademark of Woodall Industries, Inc.

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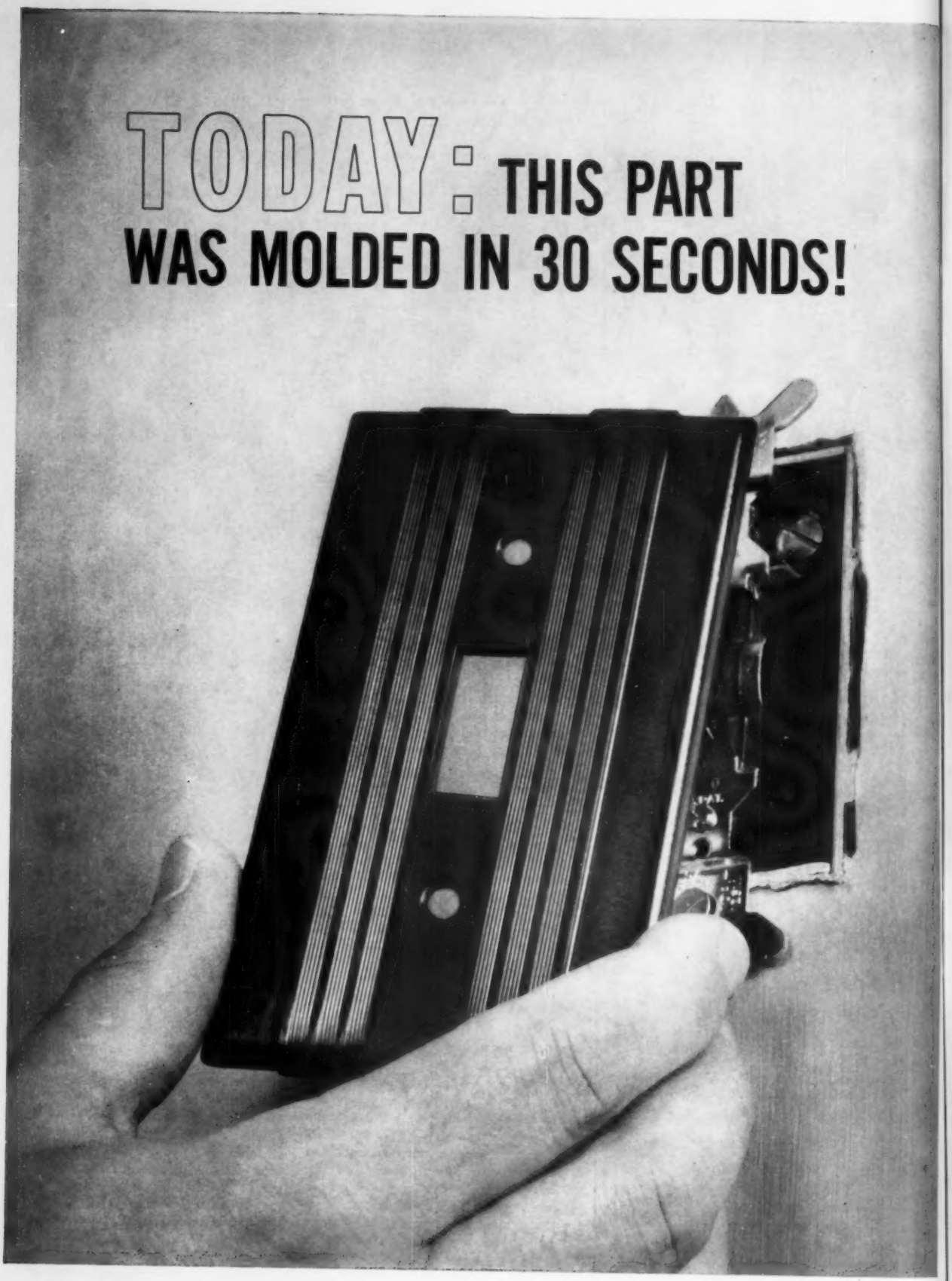
TODAY: THIS PART
WAS MOLDED IN 30 SECONDS!

# IN 1951: It took a minute and a quarter!
# IN 1931: Over two minutes!

New BAKELITE BMM-7017 is one of the fastest-curing phenolics available. Nothing old about this workhorse—it dramatically highlights an overall 300% improvement in cure speed since 1931!

To stay new in phenolics takes research and development—in real depth. To give the manufacturer continuing improvements in moldability *and* product takes a complex team of men and equipment. You'll find them at UNION CARBIDE. For example, here are 4 new BAKELITE compounds you'll want to know more about:

**BMM-7017,** a general purpose two-step compound, is setting new production records in the field. Excellent mold and flash release. In cold powder automatic molding, 15% to 40% cycle reductions in fast-acting presses. Supplied in a new dust-free 16 mesh granulation.

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**BMG-2933,** originally developed for vaporizers, gives excellent resistance to boiling water and low-pressure steam. High impact strength and fast cure as well. A one-step compound, it imparts no odor or taste to boiling water, keeps its good appearance after steam sterilizing.

**BMGA-4127** and **BMGC-4011** still in the development stage, promise completely new thresholds of heat- and arc-resistance for phenolics. Laboratory tests reveal 4 times longer strength retention at 500°F. Can be used at temperatures 75° higher. ASTM arc-resistance values: 195 seconds average . . . 180 seconds minimum.

Want more information about new developments in BAKELITE phenolics? Just write Union Carbide Plastics Company, Dept. JZ-105P Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. *In Canada:* Union Carbide Canada Limited, Toronto 12.

UNION CARBIDE **PLASTICS**

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**FIFTY YEARS EXPERIENCE IN PHENOLICS**

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# Book Reviews

**"Polypropylene."** Theodore O. J. Kresser. Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. Cloth, 5 by 7½ inches. 268 pages. $6.50.

This recent addition to Reinhold's plastics applications series is one of the first compilations of data on polypropylene. Because of its newness (polypropylene was commercially introduced here only four years ago), this material is still the subject of much research. The results of this research may limit the length of usefulness of this little book, but at the present time, it will serve as an adequate source of background information for non-technical personnel.

The book follows the format of the other materials volumes in this series: discussion of physical and chemical properties precedes sections on processing and applications. As might be expected, the author has included much of the basic chemistry information on polypropylene which we owe to Professor G. Natta. Mr. Kresser defines the stereochemical terms used in discussing the chemistry of polypropylene, and goes into just enough stereochemistry so that the uninitiated reader will have some idea of its importance in relation to this material. For those who are familiar with the chemistry, properties, and processing of linear polyethylene, there are many comparisons between this material and polypropylene.

The section on processing skirts detailed techniques, inasmuch as polypropylene is fabricated on basically conventional equipment. It is concerned, however, with the modifications of this equipment which improve polypropylene moldings. Enough is said about the basic processes merely to introduce the reader with no knowledge of them.

Emphasis in this volume is on applications, both present and predicated. Applications are divided into three chapters: packaging, hard goods, and soft goods. The chapter on packaging points out markets and competition for polypropylene film, containers, skin packages, etc. Hard goods include both industrial and consumer products. Soft goods include, among other things, polypropylene fibers.

**"Materials in Nuclear Applications — STP 276."** American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. Cloth, 344 pages, 6 by 9 inches. $8.25.

The most extensive volume ever published by ASTM in the nuclear energy field, this book includes papers presented at three symposia: "Radiation Effects and Dosimetry," "Postirradiation Effects in Polymers," and "Ceramics in Nuclear Energy."

The Symposium on Radiation Effects and Dosimetry contains seven papers which attempt to clarify some of the confusion existing in the field of radiation dosimetry and to summarize some of the latest data on the effects of radiation on various materials.

The Symposium on Postirradiation Effects in Polymers contains four papers describing the existence of long-lived, chemically active, free radicals in irradiated polymers. One paper describes some of the recent techniques for studying the identity, concentration, and lifetime of these species. The others deal with actual postirradiation changes in physical and chemical properties of a few selected polymer systems: polystyrene and poly(methyl methacrylate), silicones, and monomers and polymers in general.

Also included are two papers presented at the Symposium on Technical Developments in the Handling and Utilization of Water and Industrial Water. One describes the system for disposal of radioactive waste waters at the Hanford operation; the other outlines methods for the determination of radioactive materials in water.

**"Guide to Education Aids Available from the Chemical Industry."** Manufacturing Chemists' Association, Inc., 1825 Connecticut Ave., N. W., Washington 9, D. C. Paper, 8½ by 11 inches, 14 pages. $0.15.

This descriptive guide lists educational publications about chemicals, chemical processes, and the chemical industry. The publications are available from the MCA and its member companies, and are suitable for use at the high school level.

The booklets and pamphlets listed are broken down into 11 categories, beginning with a general chapter on the chemical industry. The section on plastics includes "The ABC's of Plastics" (Union Carbide), several pamphlets on materials, and a few on manufacture and uses. Some are available only to teachers; others to teachers and students.

**"Mathematical Handbook for Scientists and Engineers: Definitions, Theorems, and Formulas for Reference and Review."** Granino A. and Theresa M. Korn. McGraw-Hill, 327 W. 41st St., New York 36, N. Y. Cloth, 6 by 9 inches, 960 pages. $20.00.

This reference is planned to provide mathematical definitions, formulas, theorems, and methods for engineers, scientists, research workers, and others whose work involves the use of mathematics and its methodology. Among the subjects covered are algebra, analytic geometry, calculus, vector analysis, integrals, Fourier analysis, probability theory, random processes, and numerical computation.

For specific applications, each of the 21 chapters is arranged to permit the review of a complete mathematical subject; for a broad view, chapter introductions, notes, and cross-references interrelate the various topics. The book features connected outline of mathematical models essential to exact scientific methods. By the use of concise tables and boxed groups of related formulas, and omission of all proofs, a full-range of mathematical facts and data has been included in one volume. The detailed index can be used as a mathematical dictionary, and individual chapter references and bibliographies guide the reader to more advanced treatment in specific areas of interest.

**"Federal Agencies Financing Research."** Social Legislation Information Service, Inc., 1346 Connecticut Ave., N. W., Washington 6, D. C. Paper, 8½ by 11 inches, 26 pages. $1.00.

Subtitled "The Complete 1961 Guide to Government Grants and Contracts," the booklet is designed to help persons or companies hoping to work on government research projects. It provides information on the programs, procedures, and organization of each U. S. agency awarding such contracts, as well as the officer to approach for further specifics. It supplies information on the types of problems each organization is interested in financing, as well as the general pattern of awards in the past.

A subject index in the beginning directs the reader to the proper agency. For example, a chemical company would refer to the nine departments which award contracts in chemistry, including the AEC, Department of Agriculture, and Bureau of Standards.

**"Plastics Technical Dictionary."** Vol. II. German-English. A. M. Wittfoht. Carl Hanser Verlag, Munich, W. Germany. Cloth, 5 by 7½ inches, 573 pages. DM. 58.

The first edition of Wittfoht's dictionary, which appeared in 1948 as the first special dictionary for the industry, combined the section English/German and German/English in one small book, useful enough as far as it and the industry went at the time. Since then the plastics industry has developed beyond what even optimists could foresee, bringing with it the need for a considerably enlarged edition. Answering this need, Vol. I (English/German) of a two-volume work was prepared and published in 1956. Now Vol. II (German/English) has appeared. Like Vol. I, it presents besides the dictionary proper, appendices offering illustrated details of processing methods and machinery, general and technical abbreviations, and conversion and comparison tables.

The dictionary section not only covers recent developments in applications and processing of plastics, but includes terms pertaining to wood products, textiles, foams, adhesives, etc. Evident pains have been taken to be as clear and full as possible, and if occasional lacks, slips, and errors can be pointed out, the volumes still remain valuable and welcome aids, probably the best available on plastics for the German language.

# Article Abstracts

## Materials

**"Laminate Technique,"** John Miglarese, PLASTICS WORLD, 19, 6, 44 (June 1961).

Steps in developing and evaluating heat-resistant phenolic laminates are described.

**"Two Tough Plastics,"** E. A. M. Bradford, PLASTICS AUSTRALIA, 12, 4, 28 (April 1961).

Brief description of two new PTFE plastics.

**"The Assessment of the Physical Properties of Rigid Expanded Plastics,"** T. L. Phillips & D. A. Lannon, BRIT. PLASTICS, 34, 5, 236 (May 1961).

Physical property test results are discussed.

**"One-Shot Urethane Foams of Polyethers,"** P. G. Mack, INDIAN PLASTICS REVIEW, pg. 11 (March 1961).

Brief discussion of the foams and their manufacturing problems.

**"Orientation Characterization in Plastic Film and Sheet,"** C. T. Hathaway, SPE J., 17, 6, 567 (June 1961).

A simple test for measuring orientation stress is described.

**"Decorating of Plastics,"** T. E. Hayden & John Scharnberg, SPE J., 17, 6, 576 (June 1961).

Comprehensive review of decorating methods, including spray coating, silk screening, and vacuum metallizing.

**"Instrumental Specification of Color,"** David Penn & Harold Baker, SPE J., 17, 6, 580 (June 1961).

Color matching by means of a reflectance meter is discussed.

**"Two Flexible Epoxy Resins,"** R. F. Helmreich & L. D. Harry, SPE J., 17, 6, 583 (June 1961).

Description of two bisphenol-based epoxies.

**"Rigid Moltoprene, a Polyurethane for Thermal Insulation,"** F. K. Brockhagen, KUNSTSTOFFE, 51, 5, 246 (May 1961).

The position of Moltoprene foam is discussed, with emphasis on material developments in recent years and the use of new blowing agents.

**"The Promotion and Retardation of Cross-Linking in Thermally Processed Polyvinyl Chloride Systems,"** C. H. Fuchsman, SPE J., 17, 6, 590 (June 1961).

Discussion of how zinc compounds, phenolic compounds, amines, and phosphites affect cross-linking.

**"Vinyl Plasticizers: Solvating Power Versus Structure,"** W. J. Frissell, MODERN PLASTICS, 38, 9, 232 (May 1961).

Test results on plasticizer efficiency are given.

**"Adsorption of Polymers on Glass and Other Substrates—Part II,"** R. R. Stromberg & G. M. Kline, MODERN PLASTICS, 38, 9, 241 (May 1961).

This concluding part deals with temperature effects and adsorptive behavior.

**"Biaxially Stretched Acrylic Sheet,"** J. W. Ladbury, TRANS. PLASTICS INST., 28, 77, 184 (Oct. 1960).

A comprehensive discussion of biaxial stretching, its equipment, results on the finished sheet properties, and suggested applications.

**"Silicones in the Plastics and Rubber Industries,"** P. A. J. Gates, TRANS. PLASTICS INST., 28, 77, 194 (Oct. 1960).

A review of silicone laminates and rubbers.

**"The Mechano-Chemical Degradation of Plastomers,"** R. J. Ceresa, TRANS. PLASTICS INST., 28, 77, 202 (Oct. 1960).

A survey of the methods by which high polymers have been mechanically degraded.

**"The Aging of Plastics—Part 2,"** P. Dubois and J. Hennicker, PLASTICS (LONDON), 25, 277, 474 (Nov. 1960).

In this part of the article, initiated in the October issue, the authors discuss the anticipation and prevention of aging, preparation of specimens, conditions for accelerated aging, etc.

**"New Blowing Agents for Foaming Plastics,"** R. A. Reed, BRIT. PLASTICS, 33, 10, 468 (Oct. 1960).

A review of new agents and their relation to previously known agents.

**"Weatherability of Polyolefins Containing Ultraviolet Inhibitors,"** R. E. Gibson, WESTERN PLASTICS, 8, 4, 37 (April 1961).

A report on use of U-V inhibitors in polyolefins.

**"The Effect of Atmospheric Humidity on the Surface Resistance of Plastics,"** H. Weinert, PLASTE U. KAUTSCHUK, 7, 10, 480 (Oct. 1960).

It is shown that surface resistance of plastics under high humidity is far below the values given in the literature, hence insulations should first be tested under the conditions in which they may be used. Tests with a special East German device are described and measurements for various insulation materials are given, as well as graphs showing the relation of surface resistance to relative humidity. Ways of minimizing the effect of high humidity are indicated. (In German.)

**"Live Polymers,"** R. Costelli, MATERIE PLASTICHE, 26, 11, 1062 (Nov. 1960).

The discovery and investigation by Szwarc and colleagues of the so-called "live polymers," offer means of strictly controlling the molecular weights of polymers. The author describes the polymerization mechanism and the preparation of these polymers, and also considers the possibilities presented for producing various predetermined types of copolymer structures. (In Italian.)

**"Present Status of PeCe Manufacture,"** R. Kuschk and H. Kaltwasser, PLASTE U. KAUTSCHUK, 7, 11, 528 (Nov. 1960).

In East Germany, chlorinated PVC is known as PeCe or PC. Fundamental work on the process is said to have started in Germany in 1930, leading to the production of the world's first wholly synthetic fiber. After 1945, production began in Russia and also in Yugoslavia. The authors discuss the principles of PVC chlorination, its effect on solubility, technical details of the production of PC, and applications for fiber, varnish and as thermoplastics, as well as economic aspects of the process. (In German.)

**"Plasticization of PVC,"** H. Passedouet, PENSEZ PLASTIQUES, 8, 225, 5 (Jan. 1961).

The author concludes his review of plasticizers and the plasticization of PVC with a general discussion of epoxide and special plasticizers. (In French.)

**"Effect of Temperature of PVC Pastes,"** Z. Czuros, M. Groszmann and K. Juhasz, OFF. MATIERES PLAST., 8, 80, 317 (April 1961).

Work on the effect of temperature on PVC pastes prepared with dialkyl phthalate type plasticizer, indicated that the swelling point of these pastes is lower than that of dilute suspensions and that this point marks the temperature of

minimum viscosity. A scientific explanation is given of this phenomenon. (In French.)

**"Plastics Incorporating Lubricants,"** H. H. Reinsch, PLASTVERARBEITER, 12, 1, 22 (Jan. 1961).

The advantages and disadvantages of plastics, particularly polyamides, in which are incorporated a lubricant based on $MbS_2$ are discussed, and effects of this lubricant compared with those of graphite. (In German.)

**"Guide to Corona Film Treatment,"** J. C. von der Heide & H. L. Wilson, MODERN PLASTICS, 38, 9, 199 (May 1961).

New design of electrodes effects treatment of polyethylene film.

**"Penton, A New Engineering Thermoplastic,"** G. M. Taylor and E. C. Wenger, PLASTICS AUSTRALIA, 12, 5, 22 (May 1961).

A brief account of the development and properties of Penton.

**"Biaxial Stretching of Polypropylene—Part 1,"** J. Jack, BRIT. PLASTICS, 34, 6, 312 (June 1961).

The first of a two-part article reviews the theoretical background of the subject.

**"The Influence of Lubricants on Rigid P.V.C.,"** Ulf Jackson, BRIT. PLASTICS, 34, 6, 328 (June 1961).

A study of the effects of lubricants in rigid PVC.

**"P.V.C. Sheet as a Surface Finish,"** W. E. Martin, PLASTICS (LONDON), 26, 279, 103 (Jan. 1961).

A review of PVC coatings for metal and other hard substrates.

**"The Aging of Plastics—Conclusion,"** P. Dubois and J. Hennicker, PLASTICS (LONDON), 26, 279, 115 (Jan. 1961).

In this last section of a four-part article, the authors discuss the correlation between natural and artificial aging.

**"The Use of Technical Statistics in Plastics Testing and Standardization,"** W. Ploch, KUNSTSTOFFE, 51, 5, 252 (May 1961).

The use of statistical methods is shown to be of value.

**"Linear and Non-Linear Retardation Behavior of Low-Pressure Polyethylene,"** F. Schweiger, KUNSTSTOFFE, 51, 5, 256 (May 1961).

Creep test results are used to explain linear and non-linear behavior.

**Requests for copies, reprints, or further information on any article abstracted in this department should be addressed to the publisher of the magazine where the article appeared. The publishers and their addresses are given below:**

"Applied Plastics"
The Scientific Press, Ltd.
11 Gloucester Road
London, S.W. 7, England

"Australian Plastics"
Australian Trade Publications, Ltd.
243 Elizabeth Street, Suite 406,
Sydney, N.S.W., Australia

"British Plastics"
Iliffe & Sons, Ltd.
Dorset House, Stamford St.
London, S.E.I., England

"Canadian Plastics"
341 Church St., Toronto, Ont., Canada

"Chemical and Engineering News"
1155 Sixteenth St., N.W.
Washington 6, D.C.

"Chemical Processing"
Putman Publishing Company
111 E. Delaware Place
Chicago 11, Illinois

"Flexography"
Graphic Magazines, Inc.
61 Hilton Avenue
Garden City, New York

"Gummi Asbest Kunststoffe"
A.W. Gentner K G
Halle 15, Stand Nr. 15a
Stuttgart, W. Germany

"Hule Mexicano y Plasticos"
Filomeno Mata 13-11, Mexico, D.F.

"Indian Plastics"
4 Upper Chitpur Rd.
Calcutta 7, India

"Industrial and Engineering Chemistry"
1155 Sixteenth St., N.W.
Washington 6, D.C.

"Industries des Plastiques Modernes"
Les Publications Techniques Associees
40 Rue du Colisee, Paris 8e, France

"Insulation"
Lake Publishing Corp.
311 East Park Avenue
Libertyville, Illinois

"International Plastics Engineering"
Iliffe & Sons, Ltd.
Dorset House, Stamford Street
London, S.E.I., England

"Jornal de Plasticos"
Av. Rio Branco, 211
Sao Paulo, Brazil

"Kunststoffe"
Carl Hanser Verlag
Leonard Eck Str. 7, Munich 27,
Germany

"Kunststoff Berater"
Kettenhofweg 111
Frankfurt A.M., Germany

"Kunststoff-Rundschau"
Brunke Garrels, Verlagsbuchhandlung
Borgfelder Strasse 83, Hamburg 26,
Germany

"Materials in Design Engineering"
Reinhold Publishing Corp.
430 Park Ave., New York 22, N. Y.

"Materials Research & Standards"
American Society for Testing Materials
1916 Race Street
Philadelphia 3, Pa.

"Materia Plastiche"
Via Farneti 8, Milan, Italy

"Matiéres Plastiques"
Galerie du Center, Bloc 3
Rue des Fripiers, Brussels, Belgium

"Mechanical Engineering"
American Society of Mechanical
Engineers
29 W. 39th St., New York 18, N. Y.

"Modern Plastics"
575 Madison Ave., New York 22, N. Y.

"Oesterreichische Plastic-Rundschau"
Ployer & Co.
Aegidiengasse 5, Vienna 6, Austria

"Pensez Plastiques"
Les Editions De Berne et Cie 11,
Boulevard des Batignolles, Paris 8e,
France

"Plaste und Kautschuk"
Veb Verlag Technik
12 Unter den Linden
Berlin, N.W. 7, Germany

"Plastic"
Danish Technical Press
31 Vester Farimogsgade
Copenhagen 5, Denmark

"Plastica"
Kunststoffeninstituut T.N.O.
Jullienalaan 134, Delft,
The Netherlands

"Plastics"
Temple Press, Ltd.
Bowling Green Lane, London E.C. 1
England

"Plastics Age News"
Plastics Age Co., Ltd.
34 Higashi-Shimizu-machi
Minami-ku
Osaka, Japan

"Plastics Design & Processing"
Lake Publishing Corporation
311 East Park Avenue
Libertyville, Illinois

"Plastics in Australia"
Bell Publications
Box 4850
G.P.O. Sydney, Australia

"Plastics Industry"
130 Clarendon St.
Boston 16, Mass.

"Plastics Industry News"
Institute of Polymer Industry, Inc.
Mitsubishi-Maka- 6-1
Marunouchi, Chiyoda-ku
Tokyo, Japan

"Plastics World"
Cleworth Publishing Co., Inc.
1 River Road, Cos Cob, Conn.

"Plastiques Informations"
94 Rue Saint-Lazare
Paris 9e, France

"Plastverarbeiter"
Rudolf Zechner Verlag, G.m.b.H.
Speyer/Rhein, Germany

"Poliplasti"
E.T.A.S., Via Andrea Mantegne 6,
Milan, Italy

"Practical Plastics"
Box 4850
G.P.O. Sydney, Australia

"Progressive Plastics"
481 University Avenue
Toronto 2, Canada

"Revista de Plasticos"
Inst. "Alonso Barba"
Serrano 119, Madrid, Spain

"Rubber and Plastics Age"
Rubber and Technical Press, Ltd.
Tenterden, Kent, England

Soviet Plastics ("Plasticheskie Massy")
Rubber and Technical Press Ltd.
Gaywood House
Great Peter Street
London, S.W.1, England

"SPE Journal"
65 Prospect St., Stamford, Conn.

"Transactions of the Plastics Institute"
6 Mandeville Place, London W.1
England

"Western Plastics"
Western Business Publications
274 Brannan Street
San Francisco 7, Calif.

**"Technological Considerations in Processing Polypropylene,"** G. W. van Raamsdonk, KUNSTSTOFFE, 51, 5, 269 (May 1961).

A discussion of molding behavior.

**"The Significance of Shrinkage in Injection Molding of High-Density Polyethylene. II. Precautions for Decreasing Shrinkage Stresses,"** H. Bauschel & H. Peters, KUNSTSTOFFE, 51, 5, 277 (May 1961).

Ways and means to decrease internal stresses because of shrinkage.

**"Manufacture and Application of Akulon,"** L. Maaskant and J. van Eck, KUNSTSTOFF-RUNDSCHAU, 7, 12, 582 (Dec. 1960).

Akulon, usually Nylon 6, although it is also produced in the form of Nylon 6/6, is made in the Netherlands by the Algemene Kunstzijde Unie, Arnheim. The polymerization process and various technical applications of the material are discussed. (In Dutch.)

**"Flame Retardant Coatings for Plastics,"** B. J. Tyler, MATERIALS DESIGN ENG., 52, 5, 16 (Nov. 1960).

Use of an intumescent coatings is suggested for fire retardancy.

**"Fluorine-Containing Polymers,"** L. E. ROBB, WESTERN PLASTICS, 7, 12, 22 (Dec. 1960).

A brief review of methods of production and properties of these polymers and copolymers.

**"One-Shot Urethane Foams of Polyethers,"** G. P. Mack, APPLIED PLASTICS, 3, 12, 36 (Dec. 1960).

The production and use of certain organo-tin compounds is reviewed.

**"The Properties of a New Polyfunctional Epoxide Resin,"** J. A. Banks, P. Bosworth, and P. H. R. B. Lemon, BRIT. PLASTICS, 33, 12, 571 (Dec. 1960).

An epoxide resin of higher functionality than 2 is shown to give higher heat distortion points than a conventional bisphenol-A resin. The effects of cure time on strength and heat resistance values of glass cloth laminates made by the prepreg process also is indicated.

**"Antioxidants for Stablilizing Plasticized P.V.C.,"** H. C. Murfitt, BRIT. PLASTICS, 33, 12, 578 (Dec. 1960).

A review of antioxidants and their usage.

**"Flammability Tests for Plastics,"** W. J. Sauber and G. A. Patton, PLASTICS WORLD, 18, 12, 40 (Dec. 1960).

Ignition and burning tests are shown to aid in understanding flammability of a material.

## Equipment

**"Molding Presses—Part 1,"** FLEXOGRAPHY, 6, 6, 20 (June 1961).

The first of a series on plate molding equipment.

**"Bulk Handling System for Vinyl Resin,"** James Dawson & John Bennett, PLASTICS WORLD, 19, 6, 72 (June 1961).

Brief description of the Young Machinery Corp. system.

## Applications

**"Synthetics in Paper Coating,"** E. G. Curphey, PLASTICS (LONDON) 26, 279, 113 (Jan. 1961).

A study of styrene copolymers in paper coating.

**"Reinforced Plastics in the Chemical Industry,"** R. R. Guest, APPLIED PLASTICS, 4, 4, 58 (April 1961).

Various aspects are described, including epoxy and furane resins, reinforcements, laminates, sheets, filament winding, and chemical resistance.

**"Plastics in Foodstuffs Applications—Part 1,"** I. Phillips and G. C. Marks, BRIT. PLASTICS, 34, 6, 319 (June 1961).

This beginning of a two-part article reviews toxicity and test regulations.

**"Plastics Replica Mirror Segments for a Solar Furnace,"** J. Bolin, C. J. Teankest, and C. J. Milner, BRIT. PLASTICS, 34, 6, 325 (June 1961).

A study of the construction and materials in making mirrors for the Kensington solar furnace.

**"The Molded-In Hinge in Polypropylene Components,"** R. D. Hanna, PLASTICS WORLD, 19, 5, 14 (May 1961).

Principles, properties, basic design, and molding techniques are discussed.

**"The Joining of Ziegler Polythene Pipes,"** K. Richard, E. Gaube, and G. Diedrich, PLASTICS (LONDON), 26, 279, 108 (Jan. 1961).

A study of materials and results obtained by different joining methods.

**"Polyethylene Plastiatrics,"** P. J. Meeks, PLASTICS IN AUSTRALIA, 12, 3, 24 (March 1961).

A discussion of molecular behavior of polyethylene, some of its inherent problems, and possible control.

**"Behavior of PVC and Polyethylene Pipes in Burning Buildings,"** M. Friedrich & B. R. Hinrichs, KUNSTSTOFFE, 51, 3, 126 (March 1961).

Test results show that a thin layer of plaster prevents destruction of plastic pipes and incendiary spread through ceilings and walls.


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*Abstracts of Important Articles (Cont'd.)*

**"Measurement of Calibration Devices for Extruded Plastic Pipe,"** G. Schenkel, KUNSTSTOFFE, 51, 3, 153 (March 1961).

Simple directives are formulated for analyzing thermal conductivity problems.

## CALENDAR of COMING EVENTS

**October 4-6**
American Management Association Orientation Seminar. Plastic Containers for Packaging. Hotel Astor, New York, N. Y.

**October 5**
SPE Buffalo Section RETEC. Plastic Foams. Lafayette Hotel, Buffalo, N. Y.

**October 9-11**
TAPPI Plastics-Paper Conference. French Lick-Sheraton Hotel, French Lick, Ind.

**October 12-13**
SPI New England Section Conference. Wentworth - by - the - Sea, Portsmouth, N. H.

**October 16-19**
TAPPI Engineering Conference. Economic Solutions through Engineering. Shoreham Hotel, Washington, D. C.

**October 17-19**
Plastics Show of Canada. Automotive Building, Exhibition Park, Toronto, Canada.

**October 25**
SPE Kentuckiana Section RETEC. Plastics in Major Household Appliances. Monogram Hall, General Electric Co., Appliance Park, Louisville, Ky.

**October 26-27**
Plas-Tech Equipment Corp. Third Annual Symposium on High-Speed Testing. Hotel Somerset, Boston, Mass.

**November 2-3**
SPE North Texas Section RETEC. Plastics in Packaging and Engineering Exhibition. Sheraton-Dallas Hotel, Dallas, Tex.

**November 15**
SPE New York Section RETEC. Vinyl Plastics in the Household. Statler-Hilton Hotel, New York, N. Y.

**November 26-December 1**
ASME Winter Annual Meeting. Statler-Hilton Hotel, New York, N. Y.

**November 28-30**
Building Research Institute 1961 Fall Conferences. Mayflower Hotel, Washington, D. C.

**November 29-December 1**
U. S. Army Signal Research and Development Laboratory. Wire and Cable Symposium. Berkeley-Carteret Hotel, Asbury Park, N. J.

**December 1**
SPE Cleveland Section RETEC. Plastics Screw Injection Molding. Cleveland Engineering Society Building, Cleveland, O.

**January 30-February 2**
SPE 18th ANTEC. Penn-Sheraton Hotel, Pittsburgh, Pa.

**February 6-8**
SPI 17th Reinforced Plastics Division Conference. Edgewater Beach Hotel, Chicago, Ill.

**March 6-7**
Society of Vacuum Coaters. 5th Annual Technical Conference. Sheraton-Cleveland Hotel, Cleveland, O.


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# Domestic Production and Sales of Plastics and Resin Material, April and May, 1961

Following are the partly estimated and revised statistics for the domestic production and sale of plastics and resinous material during the months of April and May, 1961. Units listed are in pounds, dry basis unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily limited to the protective coating industry.

| | April, 1961 | | May, 1961 | |
|---|---|---|---|---|
| | Production | Sales | Production | Sales |
| Cellulose Plastics: | | | | |
| Cellulose acetate and mixed ester: | | | | |
| Sheets, under 0.003 gage | 1,567,261 | 1,517,798 | 1,590,187 | 1,565,902 |
| Sheets, 0.003 gage and over | 1,774,492 | 1,689,425 | 1,965,127 | 1,935,838 |
| All other sheets, rods, and tubes (including other cellulose plastics) | 811,227 | 848,850 | 840,285 | 943,609 |
| Molding and estrusion materials (including cellulose plastics) | 7,057,471 | 6,695,806 | 7,474,753 | 7,393,810 |
| Nitrocellulose sheets, rods, and tubes | 88,031 | 82,426 | 103,246 | 73,077 |
| TOTAL | 11,298,482 | 10,834,305 | 11,973,598 | 11,912,236 |
| Phenolic and Other Tar-Acid Resins: | | | | |
| Molding materials | 16,232,842 | 15,563,074 | 17,382,592 | 16,475,486 |
| Bonding and adhesive resins for— | | | | |
| Laminating (except plywood) | 5,150,137 | 3,331,173 | 5,703,924 | 3,639,029 |
| Coated and bonded abrasives | 1,098,649 | 963,032 | 1,108,485 | 1,108,639 |
| Friction materials (brake linings, clutch facings, and similar materials) | 801,755 | 787,578 | 1,411,993 | 1,103,124 |
| Thermal insulation (fiber glass, rock wool) | 7,254,793 | 3,758,533 | 7,494,495 | 4,144,927 |
| Plywood | 5,716,830 | 4,446,328 | 6,126,809 | 5,493,538 |
| All other bonding and adhesives uses | 5,116,993 | 4,955,807 | 6,286,176 | 5,656,549 |
| Protective-coating resins unmodified and modified except by rosin | 1,504,289 | 1,263,085 | 1,812,564 | 1,664,635 |
| Rosins for all other uses | 3,766,351 | 3,653,405 | 4,146,254 | 3,792,575 |
| TOTAL | 46,642,639 | 38,822,015 | 51,475,302 | 43,078,502 |
| Urea and Melamine Resins: | | | | |
| Textile-treating and textile-coating resins | 2,033,635 | 2,004,334 | 2,388,148 | 2,168,875 |
| Paper-treating and paper-coating resins | 1,959,655 | 1,895,045 | 2,130,601 | 2,023,524 |
| Bonding and adhesive resins for— | | | | |
| Laminating | 2,298,644 | 2,092,822 | 3,078,680 | 2,332,880 |
| Plywood | 6,779,498 | 6,998,034 | 8,658,861 | 7,893,326 |
| All other bonding and adhesive uses | 3,207,182 | 3,233,484 | 4,018,507 | 3,732,608 |
| Protective-coating resins, straight and modified | 2,952,221 | 1,973,032 | 3,255,436 | 2,397,063 |
| Resins for all other uses, including molding | 8,515,589 | 8,210,596 | 8,548,282 | 9,332,907 |
| TOTAL | 27,747,054 | 26,407,247 | 32,078,515 | 29,881,183 |
| Styrene Resins: | | | | |
| Molding and extrusion materials: | | | | |
| Straight polystyrene | 23,796,193 | 20,639,394 | 26,095,722 | 21,713,859 |
| All other | 33,805,514 | 29,945,889 | 38,710,754 | 33,637,868 |
| Protective-coatings | 5,062,434 | 4,062,071 | 6,809,293 | 5,637,460 |
| Textile and paper treating and coating resins | 8,201,998 | 6,081,307 | 6,448,041 | 5,175,547 |
| All other uses | 13,652,372 | 17,469,880 | 14,642,778 | 19,696,591 |
| TOTAL | 84,518,511 | 78,189,541 | 92,706,588 | 85,861,325 |
| Vinyl and Vinyl Chloride Resins: | | | | |
| Polyvinyl chloride and copolymer resins (50% or more PVC) for— | | | | |
| Film (resin content) | | 7,437,908 | | 8,833,009 |
| Sheeting (resin content) | | 10,134,644 | | 11,396,552 |
| Molding and extrusion (resin content) | | 23,058,700 | | 26,030,303 |
| Textile and paper treating and coating (resin content) | | 5,237,039 | | 5,936,419 |
| Flooring (resin content) | | 15,574,880 | | 15,346,104 |
| Protective coating (resin content) | | 2,943,004 | | 3,437,067 |
| All other uses (resin content) | | 11,134,304 | | 10,442,340 |
| All other vinyl resins for— | | | | |
| Adhesives (resin content) | | 5,186,876 | | 5,817,684 |
| Protective coatings (resin content) | | 2,210,797 | | 3,016,948 |
| All other uses (resin content) | | 10,455,448 | | 10,580,104 |
| TOTAL | 97,540,539 | 93,373,600 | 104,463,724 | 100,836,530 |
| Coumarone-Indene and Petroleum Polymer Resins | 17,297,719 | 16,896,685 | 18,174,491 | 18,976,108 |
| Polyester Resins: | | | | |
| For reinforced plastics | 11,290,554 | 12,542,836 | 12,408,473 | 12,236,332 |
| For all other uses | 2,294,580 | 1,848,778 | 2,750,012 | 1,993,730 |
| TOTAL | 13,585,134 | 14,391,614 | 15,158,485 | 14,230,062 |
| Polyethylene Resins: | | | | |
| For film and sheeting | | 40,758,509 | | 46,473,256 |
| Molding materials | | 18,421,565 | | 21,193,604 |
| Extrusion materials | | 15,350,779 | | 17,668,563 |
| For all other uses | | 48,498,205 | | 53,636,601 |
| TOTAL | 124,858,789 | 123,029,058 | 128,955,002[1] | 138,972,024[2] |
| Polypropylene Resins: | 8,669,114 | 5,080,682 | 7,642,693 | 4,797,158 |
| Epoxy Resins: | | | | |
| For protective coatings | | 1,866,143 | | 2,184,673 |
| For all other uses | | 2,540,403 | | 2,821,729 |
| TOTAL | 6,270,406 | 4,406,546 | 5,059,458 | 5,006,402 |
| Silicone Resins | | 470,474 | | 624,047 |
| Miscellaneous Synthetic Plastics and Resin Materials | 23,567,187 | 19,936,862 | 24,877,238 | 21,767,405 |
| GRAND TOTALS | 461,995,574 | 431,847,629 | 492,565,094 | 475,942,982 |

[1] 15.3% produced by the low-pressure process.
[2] 16.5% produced by the low-pressure process.
SOURCE: United States Tariff Commission Chemical Division.

# Current Market Prices

**Prices in general are f.o.b. works. Ranges indicates variations in grade, quality, quantities, and geographical locations of customers. No guarantee of these prices is made, and spot prices should be obtained by contacting this publication.**

## Catalysts

| | | | |
|---|---|---|---|
| Ammonium thiocyanate | lb. | $0.1725 / | $0.26 |
| Peroxide, acetyl, 25% in DMP | lb. | 1.75 / | 4.00 |
| Benzoyl, dry, 96% | lb. | .88 / | 2.00 |
| Wet, 50% paste in TCP | lb. | .89 / | 2.25 |
| in silicone fluid | lb. | 2.75 / | 5.00 |
| 55% in BBP | lb. | .89 / | 2.25 |
| Caprylyl, liquid, 50% in mineral oil | lb. | 4.45 / | 5.50 |
| In DOP | lb. | 5.00 | |
| Cyclohexanone, 45% paste in DBP | lb. | 2.00 / | 3.00 |
| Powder, 85%, in DBP | lb. | 3.00 / | 4.00 |
| p-Chlorobenzoyl, paste, 50% | | | |
| In mineral oil | lb. | 4.25 / | 5.00 |
| In TCP | lb. | 5.00 | |
| 2,4-Dichlorobenzoyl, 50% in silicone oil | lb. | 2.00 / | 4.25 |
| 40% in silicone oil | lb. | 4.25 / | 6.00 |
| Di-t-butyl | lb. | 1.75 / | 4.00 |
| Lauroyl | lb. | 1.55 / | 3.50 |
| Other peroxides | lb. | 1.55 / | 5.00 |

## Colorants

| | | | |
|---|---|---|---|
| Black, std. | lb. | .90 / | 4.10 |
| Carbon black | lb. | .0575/ | .87 |
| Paste | lb. | .65 / | .74 |
| Bone blacks | lb. | .155 / | .2775 |
| Gel coats | lb. | .61 / | .86 |
| Iron oxide | lb. | .1275/ | .23 |
| Lampblack | lb. | .1225/ | .175 |
| Masterbatch | lb. | .60 / | .63 |
| Paste (for epoxies) | lb. | 1.58 / | 2.15 |
| (for vinyls) | lb. | .50 / | .66 |
| Paste dispersion | lb. | .85 / | 1.90 |
| Paste concentrate | lb. | .82 / | 1.20 |
| Pigment dispersion | lb. | .83 / | 1.15 |
| Colloidal dispersions | lb. | .66 / | 1.45 |
| Aqueous | lb. | .115 / | .395 |
| Blue, std. | lb. | .90 / | 2.75 |
| Concentrate | lb. | .95 / | 3.00 |
| Masterbatch | lb. | .85 / | 1.13 |
| Pearl | lb. | 1.38 | |
| Metallic | lb. | .02 | |
| Paste (for epoxies) | lb. | 1.25 / | 2.60 |
| (for vinyls) | lb. | .62 / | 1.84 |
| Paste dispersion | lb. | .85 / | 2.40 |
| Paste concentrate | lb. | .78 / | .80 |
| Phosphorescent | lb. | .24 | |
| Brown, std. | lb. | .87 / | 4.00 |
| Copper tinsel | lb. | .10 | |
| Gel coats | lb. | .59 / | 1.04 |
| Iron oxide | lb. | .15 / | .24 |
| Metallic bronze | lb. | .02 | |
| Paste (for epoxies) | lb. | 1.18 / | 1.47 |
| (for vinyls) | lb. | .48 / | 1.67 |
| Paste dispersions | lb. | .75 / | 1.70 |
| Paste concentrate | lb. | .65 / | 2.30 |
| Gold, metallic | lb. | .21 | |
| Paste dispersions | lb. | 1.40 / | 1.60 |
| Tinsels | lb. | .10 | |
| Gray, gel coat | lb. | .59 / | .84 |
| Paste (for epoxies) | lb. | 1.40 | |
| Paste dispersion | lb. | 1.45 / | 2.20 |
| Green, std | lb. | .90 / | 3.25 |
| Chromic oxide | lb. | .45 / | 1.40 |
| Concentrate | lb. | .95 / | 3.00 |
| Metallic | lb. | .21 | |
| Phosphorescent | lb. | .24 | |
| Masterbatch | lb. | 1.20 / | 1.23 |
| Paste (for epoxies) | lb. | 2.86 | |
| (for vinyls) | lb. | .80 / | 1.83 |
| Paste dispersions | lb. | .85 / | 2.70 |
| Paste concentrate | lb. | .80 / | 2.15 |
| Pearl | lb. | .10 | |
| Orange, dry | lb. | .49 / | 3.50 |
| Gel coat | lb. | .75 / | 1.05 |
| Lithopone | lb. | 1.63 / | 1.86 |
| Paste (for epoxies) | lb. | 1.58 | |
| (for vinyls) | lb. | .74 / | 4.27 |
| Paste dispersion | lb. | .55 / | 2.80 |
| Paste concentrate | lb. | 1.58 | |
| Purple, pearl | lb. | .10 | |
| Red, std. | lb. | .1425/ | 5.00 |
| Cadium lithopone | lb. | 1.90 / | 2.86 |
| Selenide | lb. | 4.60 / | 7.15 |
| Concentrate | lb. | 2.25 / | 2.50 |
| Iron oxide | lb. | .0475/ | .205 |
| Metallic | lb. | .021 | |
| Masterbatch | lb. | .75 / | .88 |
| Paste (for epoxies) | lb. | 2.35 / | 3.77 |
| (for vinyls) | lb. | 1.20 / | 3.82 |
| Paste dispersions | lb. | .90 / | 3.05 |
| Paste concentrate | lb. | 5.42 / | 6.49 |
| Venetian | lb. | .065 / | .1325 |
| Silver, metallic | lb. | .0165 | |
| Paste (for epoxies) | lb. | 1.55 | |
| (for vinyls) | lb. | .89 / | .91 |
| Paste dispersion | lb. | $0.85 / | .45 |
| Paste concentrate | lb. | 1.02 | |
| Tinsels | lb. | .10 | |
| Yellow, std. | lb. | .12 / | 3.50 |
| Cadium lithopone | lb. | 1.21 / | 1.29 |
| Concentrate | lb. | 1.00 / | 2.50 |
| Gel coat | lb. | .61 / | 1.03 |
| Masterbatch | lb. | .90 / | .93 |
| Iron oxide | lb. | .1225/ | .1875 |
| Paste (for epoxies) | lb. | 2.15 / | 2.55 |
| (for vinyls) | lb. | .58 / | 3.70 |
| Paste dispersions | lb. | .90 / | 2.20 |
| Paste concentrate | lb. | .65 / | 2.87 |
| White, std. | lb. | .54 / | 4.00 |
| Concentrate | lb. | .70 / | 1.25 |
| Gel coat | lb. | .59 / | .84 |
| Masterbatch | lb. | .75 / | .80 |
| Paste (for epoxies) | lb. | 1.02 | |
| (for vinyls) | lb. | .48 / | .60 |
| Paste dispersion | lb. | .70 / | 2.00 |
| Paste concentrate | lb. | .705 / | .725 |
| Pearl | lb. | .10 | |

## Fillers

| | | | |
|---|---|---|---|
| Aluminum silicate pigments | ton | 21.50 / | 65.00 |
| Barytes | ton | 60.00 / | 123.00 |
| Paste concentrate | lb. | .705 / | .725 |
| Calcium carbonate, ppt | ton | 30.00 / | 187.00 |
| Std. | ton | 15.00 / | 35.00 |
| China clay | ton | 40.00 | |
| Flours | ton | 50.00 / | 106.00 |
| Flocks, cotton | lb. | .12 / | .30 |
| Rayon | lb. | .50 / | 1.25 |
| Nylon | lb. | .35 / | 2.75 |
| Mica | lb. | .075 / | 4.44 |
| Silica | ton | 25.00 / | 48.50 |
| Whiting | ton | 8.75 / | 13.25 |
| Oyster shell | lb. | 30.00 | |
| Wollastonite | ton | 29.00 / | 47.50 |

## Miscellaneous

| | | | |
|---|---|---|---|
| Anti-Fog | gal. | 8.69 / | 16.95 |
| Anti-Static | gal. | 3.57 / | 8.50 |
| (for films) | gal. | 8.00 / | 8.50 |
| Odorants | lb. | 1.25 / | 10.00 |
| Purging cmpd. (for injection) | lb. | .40 | |
| Wetting agent (for dry coloring) | gal. | 2.50 / | 3.20 |
| (for wet operations) | lb. | 2.59 / | 3.69 |

## Mold Release Agents

| | | | |
|---|---|---|---|
| Silicone type: Cmpds | lb. | 4.70 / | 5.20 |
| Aerosols | 20 oz. can | .80 / | 1.00 |
| Emulsions | lb. | 1.09 / | 1.65 |
| Fluids | lb. | 2.74 / | 6.00 |
| Solvent emulsions | lb. | .40 / | 4.95 |
| Stearates: Barium | lb. | .41 / | .46 |
| Calcium | lb. | .39 / | .44 |
| Magnesium | lb. | .42 / | .47 |
| Zinc | lb. | .41 / | .48 |

## Plasticizers

| | | | |
|---|---|---|---|
| Adipate, Butyl Cellosolve | lb. | .45 / | .47 |
| Dibutoxyethyl | lb. | .425 / | .46 |
| Didecyl | lb. | .265 / | .375 |
| Diisodecyl | lb. | .40 / | .44 |
| Diisobutyl | lb. | .41 / | .44 |
| Dioctyl | lb. | .36 / | .535 |
| Diisooctyl | lb. | .36 / | .435 |
| 2-ethyl hexyl | lb. | .36 / | .435 |
| Isooctylisodecyl | lb. | .40 / | .435 |
| Isooctyl | lb. | .49 / | .535 |
| n-Octyl decyl | lb. | .36 / | .44 |
| Azelate, dioctyl | lb. | .41 / | .49 |
| Di-2-ethyl hexyl | lb. | .40 / | .465 |
| Dibenzoate, Diethylene glycol | lb. | .285 | |
| Diethylene glycol | lb. | .45 / | .60 |
| Triethylene glycol | lb. | .60 | |
| Epoxy, polymeric | lb. | .3225/ | .3525 |
| Monomeric | lb. | .3475/ | .3775 |
| Ester, Fatty Acid | lb. | .3525/ | .3775 |
| Monomeric | lb. | .35 / | .60 |
| Laurate, Butoxyethyl | lb. | .39 / | .40 |
| Oleate, Butyl | lb. | .24 / | .33 |
| Butoxyethyl | lb. | .30 / | .33 |
| Methoxyethyl | lb. | .31 / | .34 |
| Phosphate, Tributyl | lb. | .50 / | .535 |
| Tricresyl | lb. | .325 / | .36 |
| Phthalate, Butyl Cellosolve | lb. | .35 / | .385 |
| Butyl octyl | lb. | .255 / | .30 |
| Cyclohexyl | lb. | .265 / | .305 |
| Isodecyl | lb. | $0.26 / | $0.30 |
| Butoxyethyl | lb. | .365 / | .375 |
| Dibutyl | lb. | .285 / | .43 |
| Dicapryl | lb. | .265 / | .445 |
| Dicyclohexyl | lb. | .48 / | .595 |
| Didecyl | lb. | .27 | |
| Diisodecyl | lb. | .2[illegible] | .45 |
| Diisooctyl | lb. | .26 / | .445 |
| Dioctyl | lb. | .245 / | .305 |
| Isooctyldecyl | lb. | .27 / | .45 |
| Methoxyethyl | lb. | .355 / | .405 |
| Polyester type | lb. | .34 / | .7125 |
| Polymeric type | lb. | .39 / | .93 |
| High-solvating | lb. | .37 / | .425 |
| Ricinoleate type | lb. | .32 / | .35 |
| Sebacate, Dibenzyl | lb. | .91 / | 1.04 |
| Dibutyl | lb. | .655 / | .745 |
| Dioctyl | lb. | .57 / | .6825 |
| Soy Bean oil, epoxidized | lb. | .3235/ | .4775 |
| Stearate, Butyl | lb. | .235 / | .295 |
| Butoxyethyl | lb. | .31 / | .32 |
| Epoxized octyl | lb. | .3475/ | .5325 |
| Methoxyethyl | lb. | .32 / | .35 |
| Octyl epoxy | lb | .3925/ | .447 |
| Tallate, Octyl epoxy | lb. | .3475/ | 4.025 |

## Resins, Molding, Casting & Coating

| | | | |
|---|---|---|---|
| ABS type | lb. | .44 / | 1.15 |
| Acetal | lb. | .65 / | .93 |
| Colors | lb. | .74 / | 1.24 |
| Acrylic | lb. | .46 / | 1.08 |
| Alkyd | lb. | .1325/ | 1.20 |
| Allyl (diallyl phthalate) | lb. | .95 / | 2.50 |
| Carbonate | lb. | 1.30 / | 2.25 |
| Cellulosics: | | | |
| Cellulose acetate | lb. | .35 / | .68 |
| Reprocessed | lb. | .25 / | .36 |
| Cellulose acetate-butyrate | lb. | .40 / | .81 |
| Reprocessed | lb. | .35 / | .45 |
| Cellulose propionate | lb. | .40 / | .81 |
| Ethyl cellulose | lb. | .67 | |
| Reprocessed | lb. | .30 | |
| Epoxy, liquid | lb. | .60 / | 1.41 |
| Solid | lb. | .51 / | 1.31 |
| Ethylene copolymers | lb. | .32 / | .95 |
| Fluorocarbons | lb. | 3.25 / | 11.00 |
| Furane | lb. | .75 / | 1.00 |
| Liquid | lb. | .32 / | .44 |
| Melamine | lb. | .57 / | .70 |
| Coating solns. | lb. | .3275/ | .4375 |
| Phenolic | lb. | .207 / | 1.12 |
| Coating solns. | lb. | .305 / | .3525 |
| Polyamide | lb. | .62 / | 1.26 |
| Coatings | lb. | .61 / | 1.51 |
| Graphite-filled | lb. | 1.40 / | 1.83 |
| Heat-stabilized | lb. | 1.09 / | 1.55 |
| Molybdenum sulfide-filled | lb. | 1.19 / | 2.07 |
| Polycarbonate | lb. | 1.30 / | 2.29 |
| Polyester, powder | lb. | .26 / | 2.20 |
| Coating | lb. | .0975/ | .1275 |
| Glass-reinforced | lb. | .41 / | .80 |
| Polyethylene, low-density | lb. | .2375/ | .615 |
| Medium-density | lb. | .2375/ | .6425 |
| High-density | lb. | .275 / | 1.59 |
| Polypropylene | lb. | .42 / | 1.17 |
| Reprocessed | lb. | .50 | |
| Polystyrene | lb. | .18 / | 1.34 |
| Reprocessed | lb. | .15 / | .26 |
| Rubber-modified | lb. | .20 / | .275 |
| Polyurethane | lb. | 1.30 / | 7.50 |
| Silicones, casting | lb. | 7.50 / | 11.40 |
| Molding | lb. | 2.40 / | 3.55 |
| Urea coating solns. | lb. | .205 / | .27 |
| Vinyl, dispersion grade | lb. | .24 / | .325 |
| Copolymers | lb. | .2025/ | .44 |
| Molding | lb. | .185 / | .66 |
| Nitrile rubber blend | lb. | .45 / | .53 |
| Reprocessed | lb. | .19 / | .22 |
| Vinyl-vinylidene copolymer | lb. | .185 / | .32 |
| Vinylidene | lb. | .205 / | 6.00 |
| Latex | lb. | .45 / | .52 |

## Solvents

| | | | |
|---|---|---|---|
| Ketones: Acetate | lb. | .08 / | .22 |
| Methyl isoamyl | lb. | .175 / | .315 |
| Esters: Ethyl acetate | lb. | .125 / | .2675 |
| Isopropyl acetate | lb. | .115 / | .255 |
| n-Butyl acetate | lb. | .145 / | .285 |
| Alcohols: Isobutyl | lb. | .13 / | .27 |
| n-Butyl | lb. | .155 / | .295 |

## Stabilizers

| | | | |
|---|---|---|---|
| Alkyd tin mercaptide, liq. | lb. | 2.50 / | 3.15 |
| Barium-cadmium complex: | | | |
| Liquid | lb. | .50 / | .58 |
| Solid | lb. | .97 / | 1.255 |
| Barium-cadmium laurate | lb. | .87 / | .90 |
| Myristate | lb. | .72 / | .75 |
| Barium-cadmium-zinc complex | lb. | .54 / | .56 |
| Barium-zinc, liquid | lb. | .58 / | .615 |
| Powder | lb. | .375 / | 44 |
| Complex | lb. | .47 / | .50 |
| Cadmium-barium, powder | lb. | .68 / | .895 |
| Chelating agent, liquid | lb. | .57 / | .84 |
| Cadmium-containing | lb. | .84 / | .87 |
| Zinc-containing | lb. | .62 / | .80 |
| Organic complex, liquid | lb. | .57 / | .84 |
| Strontium-zinc laurate | lb. | .72 / | .75 |
| Zinc, liquid | lb. | .48 / | .52 |

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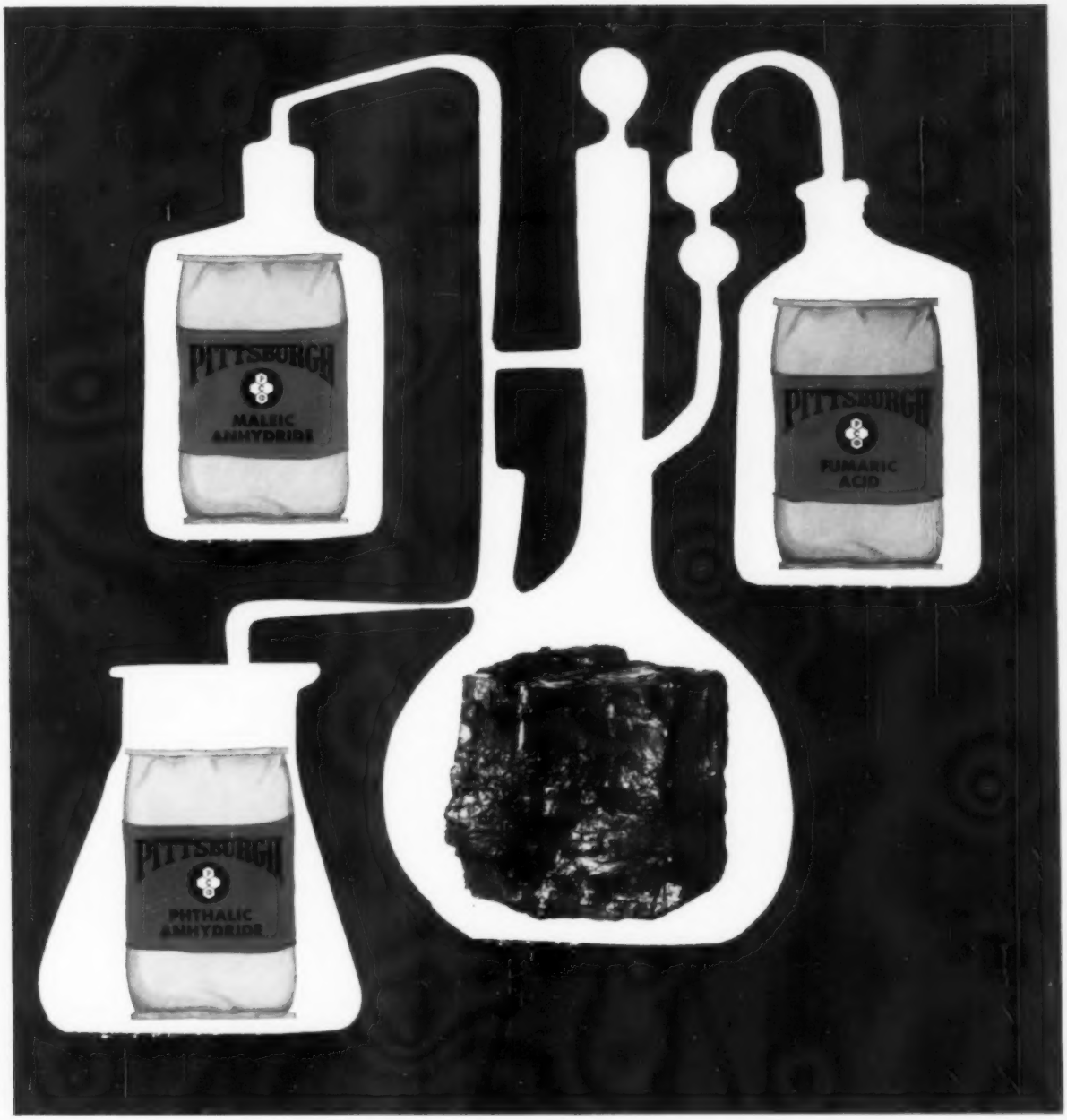


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